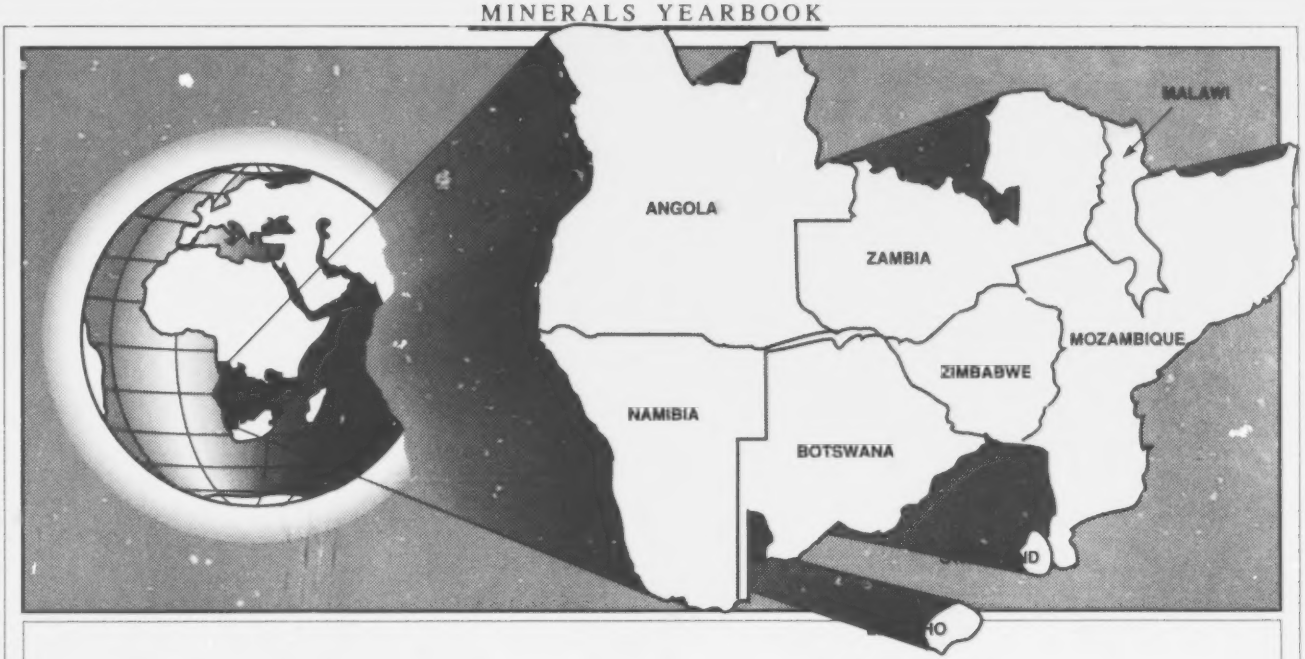
So 87 af/2/988






THE MINERAL INDUSTRIES OF

# SOUTHERN AFRICA

By George A. Morgan, Hendrik G. van Oss, Lloyd E. Antonides, and Harold R. Newman

## 1988

## INTERNATIONAL REVIEW

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

I 28.37/a 2:

READEX FICHE best copy available

THE MINERAL INDUSTRIES OF

# SOUTHERN AFRICA

U.S.
DEPARTMENT
OF THE
INTERIOR

Manuel Lujan, Jr.
Secretary

BUREAU OF
MINES

T S Ary
Director

1988

# Contents


Angola ..... 1
Production and Trade ..... 1
Commodity Review
Industrial Minerals ..... 2
Clays ..... 2
Diamond ..... 2
Salt ..... 2
Mineral Fuels ..... 2
Botswana ..... 3
Production and Trade ..... 4
Commodity Review
Metals ..... 5
Cobalt ..... 5
Copper ..... 5
Gold and Silver ..... 6
Nickel ..... 6
Platinum ..... 7
Industrial Minerals ..... 8
Clays ..... 8
Construction Materials ..... 8
Diamond ..... 8
Gem Stones ..... 8
Soda Ash ..... 9
Mineral Fuels ..... 9
Coal ..... 9
Petroleum ..... 10
Lesotho ..... 10
Malawi ..... 10
Mozambique ..... 11
Namibia ..... 14
Government Policies and Programs ..... 15
Production and Trade ..... 15
Commodity Review
Metals ..... 15
Copper ..... 15
Gold ..... 15
Lead ..... 17
Tantalum ..... 17
Tin ..... 17
Zinc ..... 17
Industrial Minerals ..... 18
Diamond ..... 18
Fluorspar ..... 18
Mineral Fuels ..... 18
Natural Gas ..... 18
Uranium ..... 18
Swaziland ..... 19
Zambia ..... 21
Production and Trade ..... 22
Commodity Review
Metals ..... 22
Cobalt ..... 22
Copper ..... 22
Gold ..... 25
Iron and Steel ..... 25
Lead and Zinc ..... 25
Nickel ..... 25
Industrial Minerals ..... 25
Gem Stones ..... 25
Nitrogen ..... 25
Sulfur ..... 25
Mineral Fuels ..... 25
Coal ..... 25
Petroleum ..... 25
Pipeline ..... 25
Zimbabwe ..... 26
Government Policies and Programs ..... 26
Production and Trade ..... 26
Commodity Review
Metals ..... 26
Chromite ..... 26
Copper ..... 26
Gold ..... 31
Iron and Steel ..... 35
Ferroalloys ..... 35
Lead ..... 35
Nickel ..... 35
Platinum-Group Metals ..... 35
Industrial Minerals ..... 36
Cement ..... 36
Lithium ..... 36
Gem Stones ..... 36
Mineral Fuels ..... 36
Coal ..... 36
Coke ..... 37
Uranium ..... 37


# Tables


Table 1.—Angola: Production of Mineral Commodities ..... 1
Table 2.—Botswana: Estimated Value of Mineral Production .... 4
Table 3.—Botswana: Estimated Value of Mineral Exports ..... 4
Table 4.—Botswana: Production of Mineral Commodities ..... 5
Table 5.—Botswana: Diamond Production in 1988, by Mine .... 8
Table 6.—Lesotho: Production of Mineral Commodities ..... 10
Table 7.—Malawi: Production of Mineral Commodities ..... 11
Table 8.—Mozambique: Production of Mineral Commodities ..... 13
Table 9.—Mozambique: Installed Tantalum Mineral Production Capacity ..... 14
Table 10.—Namibia: Production of Mineral Commodities ..... 16
Table 11.—Namibia: Gross Weight and Elemental Content of Ore and Concentrate Produced in 1988, by Mine ..... 17
Table 12.—Swaziland: Production of Mineral Commodities ..... 20
Table 13.—Zambia: Production of Mineral Commodities ..... 23
Table 14.—Zimbabwe: Production of Mineral Commodities ..... 27
Table 15.—Zimbabwe: Apparent Exports of Mineral Commodities ..... 29
Table 16.—Zimbabwe: Apparent Imports of Mineral Commodities ..... 32

*For further information, please contact*
*The Branch of Africa and the Middle East*
*The Division of International Minerals*
*U.S. Bureau of Mines*
*2401 E St. NW, MS 5205*
*Washington, DC 20241-0001*
*Telephone: (202) 632-5065*
*Fax: (202) 634-4654*

THE MINERAL INDUSTRIES OF

# SOUTHERN AFRICA

By Lloyd E. Antonides, George A. Morgan, Harold R. Newman, and Hendrik G. van Oss

## ANGOLA[1]

The Angolan economy in 1988 was dominated by the production and export of crude oil and by the ongoing civil war. Oil exports accounted for about 95% of the country's foreign exchange earnings. Expenditures related to military activities accounted for 40% of Government revenues and dominated the makeup of the country's imports.

The oil-producing regions of the country were under heavy military protection and consequently were relatively unaffected by the civil war. Crude oil production was at record-high levels during the year, which mitigated the low world oil prices in 1988. Oil exploration and development activities were also at a high level. Interest in exploration offshore southern Angola increased as prospects improved for an agreement, signed at yearend, providing for the withdrawal of foreign troops from the region.

Most mining operations in the country continued to be hampered by the civil war. Efforts, begun in 1986, to resume large-scale mining continued, with the result that production increased dramatically. As Angola has very large reserves of high-quality gem diamonds, it was felt that the country would become a major world producer of diamonds once hostilities ceased.

Preliminary work to rehabilitate the Benguela railroad began toward yearend, but was greatly hampered by the ongoing guerrilla activities. Partial funding for the project by various regional and European countries had been reaffirmed early in the year, but this was mainly for surveying of the railroad and some rehabilitation work at the Port of Lobito. The Government was seeking to join the International Monetary Fund (IMF) to attract World Bank funding for the bulk of the almost $600 million project.

Work continued on the 520-megawatt Capanda dam and hydroelectric project on the Kwanza River in Malange Province. Planned electrical capacity will almost double the country's supply. Construction was by the Brazilian firm Construtora Noberto Odebrecht and was scheduled for completion by yearend 1992, for a total cost of about $1 billion.

### Production and Trade

Production of most mineral commodities was estimated to have increased in 1988, although most mining operations continued to be hampered by warfare. Little reliable information was available on the production of many commodities.

Angola was the second largest oil producer in Sub-Saharan Africa after Nigeria. Oil production increased more than 25% to a record level of about 165

TABLE 1

**ANGOLA: PRODUCTION OF MINERAL COMMODITIES[1]**

| Commodity[2] | | 1984 | 1985 | 1986 | 1987[p] | 1988[e] |
|---|---|---|---|---|---|---|
| Asphalt and bitumen, natural[e] | metric tons | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Cement, hydraulic[e] | thousand metric tons | 350 | 350 | 350 | 350 | 1,000 |
| Diamond:[3] | | | | | | |
| Gem[e] | thousand carats | 652 | 464 | 240 | r675 | 950 |
| Industrial stones[e] | do. | 250 | 250 | 10 | r75 | 50 |
| **Total** | **do.** | **902** | **714** | **250** | **r750** | **1,000** |
| Gas, natural:[e] | | | | | | |
| Gross | million cubic feet | r85,000 | r85,000 | r85,000 | r97,000 | 97,000 |
| Marketable | do. | r17,500 | r17,500 | r17,500 | r20,000 | 20,000 |
| Gypsum[e] | metric tons | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 |
| Iron and steel: | | | | | | |
| Iron ore[e] | do. | — | — | — | — | 22,000 |
| Steel, crude[e] | do. | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Petroleum: | | | | | | |
| Crude | thousand 42-gallon barrels | r75,900 | 89,060 | 102,930 | 131,190 | 165,000 |
| Refinery products[e] | do. | r7,300 | r7,665 | r9,855 | r9,490 | e10,000 |
| Salt[e] | metric tons | 50,000 | r50,000 | r55,000 | r60,000 | 70,000 |

[e] Estimated. [p] Preliminary. [r] Revised.

[1] Table includes data available through Nov. 16, 1989.

[2] In addition to the commodities listed, a variety of crude construction materials (clays, sand and gravel, and broken stone) presumably is produced for local consumption, but information is inadequate to make reliable estimates of output levels.

[3] Does not include smuggled artisanal production.

million barrels. Because of low world oil prices, revenues from oil exports were about the same as in 1987, or about $2.1 billion.

Diamond production increased by one-third to an estimated 1 million carats, not counting unrecorded artisanal production. Revenues from official sales were an estimated $180 million.

Salt production increased significantly, largely owing to rehabilitation of state-owned saltworks in Namibe Province. Reportedly, production of iron ore resumed at the Kassinga Mine for the first time since 1975. Production was estimated at 22,000 tons. In 1981, open pit reserves at this mine were estimated to be 21.7 million tons grading 44% iron.

The United States continued to be the largest importer of Angolan oil, despite political pressure to reduce this level. In 1988, the United States imported 70.3 million barrels of crude oil from Angola, in addition to 2.8 million barrels of residual fuel oil. These represented 3.8% of total United States petroleum imports.

Angola had about $1 billion per year in bilateral trade with Brazil. It purchased about 25% of Brazil's exports to Africa, largely food, automobiles, farm machinery, and equipment for the Capanda Dam project. Angola exported oil to Brazil, including about 20,000 barrels per day as partial repayment of about $1.1 billion in loans from Brazil. Angola had trade with the Soviet Union worth an estimated $250 million. Imports from the Soviet Union included military hardware and construction material.

## Commodity Review

***Industrial Minerals.*—Clays.**—In September, the Ministry of Industry announced that the kaolin deposits in Huila Province would start to be mined toward yearend and that the expected production rate would be 150,000 tons per year.

**Diamond.**—Official diamond production continued to be through the parastatal Empresa Nacional de Diamantes de Angola (Endiama). Many of the diamonds were mined from the rich Cuango River alluvial deposits by Roan Selection Trust International, under a contract signed with Endiama in late 1986. In July 1987, Endiama signed a contract with Sociedade Portuguesa de Empreendimentos to rehabilitate mining equipment and to prospect for diamonds in the Lucapa zone in Luanda Norte Province. Several untapped diamondiferous kimberlites are known to exist in this region, of which three are reportedly very large. It was estimated that production from Lucapa could eventually boost the value of Angola's diamond production to between $500 million and $1 billion. Diamond sales have been through private channels ever since Angola ended its contract with De Beers' Central Selling Organization (CSO) in 1986. However, preliminary negotiations were underway with De Beers for the company to finance and develop the Lucapa area kimberlites. Because of the considerable costs projected for development, it was considered likely that the sales contract with the CSO would eventually be renewed.

Production estimate of about 1 million carats in 1988, reported by Endiama, did not include unrecorded artisanal production. Reliable estimates of the latter were not available, but the production was believed to be large. It was widely believed that opposition forces in the civil war were financing at least part of their efforts through the sale of such diamonds.

**Salt.**—Little information has been available in recent years on Angolan salt production and that only for production from Namibe Province. Traditionally, salt has also been produced in Benguela and Zaire Provinces.

Namibe Province has six saltworks, of which three were in the municipality of Tomwa, two in Namibe, and one in Bentiaba. Five of these saltworks, accounting for 80% of the production, were state-owned. Production from Namibe Province in 1986 slightly exceeded the record-high pre-Independence production of 23,000 tons. Production was 32,000 tons in 1987 and an estimated 36,000 tons in 1988. It was estimated that the Province exported 12,000 tons of salt in 1988. The increase in production was credited to a continuing program of rehabilitation of the saltworks and retraining of the salt workers. The Italian Government was reportedly contributing $3.5 million to this program.

***Mineral Fuels.*—**Angola was not a member of the Organization of Petroleum Exporting Countries and hence was not subject to its production constraints. Angola produced crude oil at a record average rate of about 452,000 barrels per day in 1988, the sixth consecutive year of increase, and more than three times the rate in 1982. Production continued to increase during the year, with a reported rate in November and December of 456,000 barrels per day. The record production offset the lower world oil prices. Angola's oil production was expected to reach 500,000 to 520,000 barrels per day by yearend 1990.

Virtually all of the country's oil production came from onshore and offshore Cabinda and from offshore blocks Nos. 1 to 3 in the northern part of the country. Cabinda Gulf Oil Co. (Cabgoc), a subsidiary of Chevron Oil Co., was the dominant oil producer with about 58% of the country's production. Other operators in Angola included American companies Conoco Inc., Marathon Oil Co., and Texaco Inc., as well as Société Nationale Elf Aquitaine (Elf) of France, Azienda Generali Italiana Petroli S.p.A. (Agip) of Italy, and British Petroleum Co. of the United Kingdom.

Oil exploration continued at a high rate, and substantial development was underway in both major producing areas. Offshore Cabinda, Cabgoc tied in two new deposits to facilities at its 13

producing fields. The Numbi and Wamba Fields received new platforms. The company expected to add two new pipelines to the fields in 1989, at which time the fields' production would reach 40,000 and 80,000 barrels per day, respectively. Cabgoc's total production was approximately 270,000 barrels per day toward yearend, and the company predicted that its output would rise to 300,000 barrels per day in 1990. Elf started up its new Bufalo Field in Block 3, and two other fields, Impala and Punja, were scheduled for startup in 1990. Elf produced at a rate of 120,000 barrels per day during 1988 and predicted that its 1990 Angolan production would be 150,000 barrels per day. Texaco was predicting an output of 40,000 barrels per day from its Block 2 concession by yearend, in addition to its 30,000-barrel-per-day onshore production. In July, Texaco and its partners announced their eighth discovery in Block 2, 12 kilometers offshore. The well tested at 2,880 barrels per day of 36° API crude. Its location was close to the producing Cuntala Field and was expected to be developed quickly.

Increased interest in exploration offshore Angola was due in part to recent improvements in seismic exploration technology and to a relative lack of available exploration leases elsewhere. United States-mediated negotiations, providing for the withdrawal of foreign troops from Angola, led to prospects for peace in the southern part of the country, and renewed interest in the southern offshore concessions (Blocks 9 to 13). These southern blocks, however, were not considered to have as much potential as those to the north. Several European and Japanese companies were bidding for the central-Cabinda onshore concession that state-owned Sociedade Nacional de Combustiveis de Angola (Sonangol) opened in 1986. British National Oil Corp. was awarded a 20% interest in Block 8, where Petrofina S.A. of Belgium and Compagnie Francaise des Petroles (TOTAL) each held 40%. TOTAL acquired a 15% share in Block 6, reducing Conoco's holding to 60%. Unocal held 25% of the concession.

Cabgoc sold 9.8% of the Cabinda concession to Agip, retaining 39.2%. The sale price reportedly was about $190 million. Sonangol held the remaining 51% of the concession. Braspetro, a subsidiary of Petrobras International S.A. of Brazil, purchased a 20-million-barrel oil reserve in Angola from Texaco for a reported $55 million. This represented about 10% of the reserves in Block 2, where Braspetro was doing exploration under a risk contract. The purchase boosted Braspetro's share of the field to 27.5%. Texaco assigned a further 10% of Block 2 reserves to TOTAL, which boosted TOTAL's share to 27.5% also. Texaco retained 20% of the concession, and the remaining 25% was held by Sonangol.

Sonangol's offshore fuel terminal at Lobito was under construction during the year. The terminal was to have 15 storage tanks with a total capacity of 53,000 cubic meters of fuel and lubricants. The $40 million terminal was being built and financed by Italian entities.

## BOTSWANA[2]

Minerals remained the base of Botswana's healthy economy in 1988, as had been the case for more than a decade. Diamonds were the leading commodity. The Bank of Botswana calculated that exports earned the equivalent of $1.063 billion,[3] or about 75% of the country's total export revenue. The value of production was larger than that of any other country, for the fourth consecutive year. The volume, 16.2% of world production, was the third largest after Australia and Zaire. According to published data on domestic mining companies, the country's single producer was Botswana's second largest employer, averaging 4,509 employees for the year. This was 44% of the average 10,291 workers reported in the domestic mineral industry. Total employment in the formal sector was estimated at 150,000, which reportedly included 20,000 to 25,000 working in the South African mining industry.

Nickel-copper-cobalt matte, produced by BCL Ltd.'s mining and smelting complex and refined outside the country, was the next largest source of export earnings for Botswana; this was calculated by the Bank as equivalent to $227 million or about 15% of the national total. BCL was said to be the largest private employer, averaging 4,790 employees. Data showed that the third-ranking export was beef, which earned only the Bank-calculated equivalent of $52 million. Cattle raising, however, provided a livelihood for most of the rural population, which was estimated at more than 80% of the roughly 1.2 million people in the mostly arid, Texas-sized country. Beef earnings began rising after a 6-year drought ended in January 1988; even without droughts, however, mining would remain the key element in the economy because mineral commodities provided about 90% of export earnings in 1988.

Statistically, the mineral industry contributed about 50% to the gross domestic product (GDP) and about 60% of Government revenue in 1988, according to estimates reported in mid-1989. For the economy overall, IMF figures showed the GDP for the year ending June 30, 1988, to be $1.80 billion, up 19% in pula terms, or 10% in dollars, from the year earlier. Other estimates indicated that for calendar year 1988 growth in GDP had slowed to between 8% and 9%, compared with a compound real rate of growth of more than 12% for over a decade. However, even the lower rate kept Botswana in the top ranks of the world's fastest growing economies, especially in Africa. Inflation was reported to have increased, from 1987's slightly less than 10%, to slightly more than 10%, and the pula depreciated against the U.S.

dollar by 8%, according to the IMF's year average exchange rate.

Although trade and balance of payment surpluses were large and foreign reserves continued to increase, Government officials expressed concern that Government expenditures were increasing at a rate that would overtake revenue in a few years, and production was expected to level off within 2 years. The Government also reiterated concern over the employment problem. About 25% or 40,000 of the formal sector type workers were without jobs; although each year 25,000 new job seekers were entering the market, at most 20,000 new jobs were opening up, despite a construction boom. The linkage between shortage of skilled workers, the need for more education, and the need for special inducements for expatriate workers was also pointed out. However, the expatriate workers' higher pay continued to be a cause of labor friction. The need for more infrastructure and better housing were other concerns.

The Government also was trying to encourage private enterprise, as well as diversification away from heavy reliance on mining, especially diamonds. Labor-intensive manufacturing was the stated thrust, and foreign investment was invited. At the same time, official statements and actions clearly indicated that the Government wanted to continue to attract more and wider investments in capital-intensive mining, especially where it added to the infrastructure. Most of the existing infrastructure was near the eastern border in a 100-kilometer-wide by 650 kilometers long strip along the railroad from Zimbabwe to Republic of South Africa. The country's multiparty democratic Government had a history of stability since independence in 1966 and was trying to provide an attractive investment climate.

### Production and Trade

Production of most mineral commodities increased in volume during 1988, according to statistics released by the Government and private sources. Increases were at double digit rates in almost every case. However, gold and lime were down substantially, and gem stones were down slightly. Higher commodity prices were a spur to increased output, and apparently, most producers had the capability to respond in market-oriented Botswana.

Value in pula increased even more than volume of production for most major commodities, due to the higher market prices. When measured in pula, the rise was also due to inflation and, for those commodities that were exported, depreciation of the pula's foreign exchange value.

Value of mineral exports was nearly the same in pula for 1988 and 1987 based on Bank of Botswana estimates of export values converted to millions of dollars, as shown in table 3.

The mineral component of "Other exports" probably had about the same pula value in both years converted to $330,000 in 1988 and to $358,000 in 1987. But, as shown above, in equivalent dollars, 1988's total mineral export value was less than 1987's due to the change in exchange rates. However, failure to show an increase in export value, when there was such a substantial increase in production value, was due to the sale of a large stockpile of diamonds in 1987, reportedly for the equivalent of about $596 million plus shares of stock and other nonmonetary benefits.

Government statistics show more than 85% of exports, by value, went to European nations other than the United Kingdom. Although shipments to jewelry centers presumably accounted for most of this, 75% for the nickel-copper-cobalt smelter matte was sold to refineries in Norway and the balance to refineries in Zimbabwe.

Value of imports (c.i.f.), cited in IMF data in million pula, were P1,8[illegible].8 in 1988 and P1,571.2 in 1987. South Africa continued to be the major trading partner and was said to be the source of transhipment of a least 80% of Botswana's imports. Almost all exports also passed through South Africa.

TABLE 2

**BOTSWANA: ESTIMATED VALUE OF MINERAL PRODUCTION**

| | 1988 | 1989 |
|---|---|---|
| Diamonds | $936,190,000 | $715,200,000 |
| Nickel-copper-cobalt | 236,676,000 | 85,007,000 |
| Coal | 6,223,000 | 6,140,000 |
| Gold-silver | 280,000 | 389,000 |
| Semiprecious stones | 10,000 | 15,000 |
| Lime | 14,000 | 17,000 |
| Crushed stone | 4,759,000 | 3,451,000 |
| Sand | 415,000 | 342,000 |
| **Total** | **1,186,567,000** | **810,561,000** |

Source: Botswana Department of Mines

TABLE 3

**BOTSWANA: ESTIMATED VALUE OF MINERAL EXPORTS**

(Million U.S. dollars)

| | 1988 | 1987 |
|---|---|---|
| Diamonds | 1,081.0 | 1,341.8 |
| Nickel-copper | 231.8 | 76.7 |
| **Total** | **1,312.8** | **1,418.5** |
| Other exports | 175.9 | 174.0 |
| **Grand total** | **1,488.7** | **1,592.5** |

Source: Bank of Botswana

TABLE 4

**BOTSWANA: PRODUCTION OF MINERAL COMMODITIES[1]**

(Metric tons unless otherwise specified)

| Commodity | | 1984 | 1985 | 1986 | 1987[p] | 1988[e] |
|---|---|---|---|---|---|---|
| Coal, not further described | | 392,851 | 437,053 | 499,373 | 579,409 | [2]612,873 |
| Cobalt, Co content of smelter product[3,4] | | 259 | 222 | 163 | 181 | [2]291 |
| Copper: | | | | | | |
| Mine output, Cu content of ore milled[e,5] | | r26,436 | r27,274 | r27,499 | r27,888 | 27,303 |
| Cu content of smelter product[3] | | 21,471 | 21,692 | 21,336 | 18,933 | [2]24,428 |
| Diamond: | | | | | | |
| Gem and near gem[e] | thousand carats | r5,810 | 6,318 | r9,590 | r9,368 | 10,660 |
| Industrial stones[e] | do. | 7,104 | 6,317 | 3,500 | 3,840 | 4,569 |
| **Total** | **do.** | **r12,914** | **12,635** | **13,090** | **13,208** | **[2]15,229** |
| Gem stones, semiprecious, rough, not further described[6] | kilograms | r36,700 | r14,310 | 4,900 | 40,103 | [2]38,000 |
| Gold[7] | troy ounces | 575 | 407 | 810 | 1,019 | [2]675 |
| Lime | | 43 | 2,600 | 225 | 325 | [2]226 |
| Nickel: | | | | | | |
| Mine output, Ni content of ore milled[e,5] | | r24,570 | r26,300 | r25,558 | r25,920 | 25,971 |
| Ni content of smelter product[3] | | 18,604 | 19,565 | 18,974 | 16,528 | [2]22,539 |
| Smelter product, gross weight[3] | | 51,845 | 51,507 | 47,930 | 43,238 | [2]57,530 |
| Sand and gravel | cubic meters | 188,498 | 102,524 | 129,181 | 122,203 | [2]179,936 |
| Stone, crushed, not further described | do. | 436,604 | 132,966 | 177,792 | 225,362 | [2]337,677 |

[e] Estimated. [p] Preliminary. [r] Revised.

[1] Table includes data available through July 1, 1989.

[2] Reported figure.

[3] Smelter product is granulated nickel-copper-cobalt matte.

[4] Figures also used for recoverable mine output in world production tables appearing in Volume I of the Minerals Yearbook.

[5] Calculated from reported tonnage and head grade of ore milled.

[6] Sales, probably principally agate.

[7] Gold production figures include silver reported as follows: 1984—"less than 1 kilogram" (i.e. 32 troy ounces, less than 5.6% of total), and 1987—"about 2% of total gold and silver listed" (i.e. about 20 troy ounces).

Heavy reliance on trade with South Africa was expected to continue because of proximity, location of ports, size of market, source of financing, and other economic realities, not the least of which was comembership in the Southern African Customs Unions (SACU).

## Commodity Review

***Metals.*—Cobalt.**—A 60% increase in cobalt content of the nickel-copper-cobalt matte produced by BCL Ltd. was roughly double the increase in either nickel or copper. This indicated a higher cobalt content in ore or better recoveries in processing. The matte was exported and metal recovered and refined in Norway and Zimbabwe.

**Copper.**—The increase in output of copper contained in nickel-copper-cobalt matte was in line with the increase in total matte produced by BCL Ltd. It, too, was recovered and refined in Norway and Zimbabwe.

A subsidiary of Falconbridge Ltd. of Canada was reportedly investigating copper mineralization near Francistown, 425 kilometers northeast of Gaborone. The attraction was said to be partly the new railroad planned for the Sua Pan soda ash project, about 175 kilometers northwest of Francistown. Copper deposits were known for many years to exist in a belt extending almost the whole distance westerly to Sua Pan, as well as east and south of Francistown. The entire belt apparently was in the area that Bamangwato Concessions Ltd., now BCL Ltd., explored in the 1960's prior to deciding to develop the Selebi-Phikwe nickel-copper-cobalt deposits, south of Francistown.

Copper mineralization was also known to be in an area much further west in the Kalahari Desert, about 500 kilometers west of Francistown near Lake Ngami and Maun. Previous reports claimed copper mineralization trends extended from Lake Ngami northeasterly into Zambia and westerly into Namibia.

**Gold and Silver.**—Gold continued to receive much attention. Prospecting was actively pursued, and one new mine, Map Nora, joined the ranks of several relatively small mining operations. Additional mining leases were applied for, and another one was issued to reopen old mines and/or rework tailing dumps in the Francistown area. Some silver generally is present in the ore. Most exploration was in the same area, but there apparently also was exploration in the central Kalahari Desert region, 500 kilometers to the west, where Cominco International Resources of Canada reportedly started drilling. This work was on part of a prospecting concession, described as horseshoe shaped, at least 1,000 square kilometers (one apparently normal concession unit) and possibly as much as 11,000 square kilometers according to another report. The work was in a larger area covered by an aeromagnetic survey that reportedly was funded by a Canadian aid program in the 1970's.

The Map Nora Mine of Shashe Mines (Pty.) Ltd., 8 kilometers south of Francistown, began production in December 1988, after 18 months of underground development that included a 325-meter, vertical shaft. Planned ore output is 6,600 tons per month. This apparently was the most recent shaft sinking event in a long history of gold mining, dating probably 1,400 years or more, in the Tati schist belt. In this vicinity, the first European gold-mining enterprise in southern Africa was said to have started production in 1869. About that time, the Map Nora deposits were discovered, together with many others. None of the subsequent mines were major operations, and most shut down in the early 1900's. However, a number were reworked from about 1930 to 1950, including Map Nora; some were again reopened about 1980. Complex metallurgy was said to have been a major factor limiting development.

In 1983, Phelps Dodge Corp. (PD) of the United States agreed with Falconbridge Ltd. of Canada, through their Botswana subsidiaries, to join and manage an ongoing exploration program on a concession that included numerous prospects. In June 1987, after drilling, bulk sampling, metallurgical tests, and some additional underground development at Map Nora, it was decided to start production. In December 1987, PD bought out Falconbridge's interest. The mining lease, covering 52 square kilometers and including 14 old gold workings, was apparently actually granted in March 1987 to Shashe, which at yearend 1988 was owned 85% by PD and 15% by the Government of Botswana. A second mine, Golden Eagle, was also being developed on the lease.

The Map Nora ore was described as being siliceous, associated with shear zones and sulfide mineralization, and occurring in veins typically 0.5- to 1.0-meter thick, dipping 65°, and of very variable width and grade. Ore was said often to be rich in arsenopyrite, usually to have moderate amounts of pyrrhotite and pyrite, and to contain erratic concentrations of antimony that needed blending to permit roasting. Mining by underhand open stoping was planned to deliver ore averaging 6 grams of gold per ton. Processing of the so-called refractory ore was designed to include comminution, froth flotation, fluid bed roasting, agitated leaching, carbon-in-pulp absorption, elution, and electrowinning. Overall recovery, in an 85% gold and 5% silver bullion, was expected to be about 88.5% of the gold in ore milled.

Cost of the mine, processing plant, and ancillary facilities reportedly totaled about $10 million, close to that budgeted. The original time schedule apparently was met. Planned employment of 275 people was said to be higher than optimal to accommodate expected high turnover. Processing of surface dump material and stockpiled development ore was to start in January 1989, and the plant was expected to be at design capacity treating stope ore by July 1989.

In other gold-silver mining activity in 1988, mining leases were applied for by Mecor (Pty.) Ltd. on the Tekwane deposit and by Mineral Holdings (Botswana) (Pty.) Ltd. on tailings; a mining lease was granted to Metore (Pty.) Ltd. from which production was due early in 1989; underground production by Morex Botswana (Pty.) Ltd. from the Rainbow deposit continued since startup in late 1987; underground production by Mineral Holdings (Botswana) (Pty.) Ltd., since before 1986; production from tailings by Golden sands, since before 1986; and production from tailings by Shamrock, since before 1986.

**Nickel.**—Nickel, one the country's leading exports, made headlines with new production records, new mines and new prospects. The granulated smelter matte produced by BCL Ltd. during 1988 was a company record of 47,258 tons for total contained nickel-copper-cobalt metal. During the year, 35,641 tons of contained metal were shipped to Falconbridge Ltd.'s refinery in Kristiansand, Norway; most of the 12,776 tons shipped to refiners in Zimbabwe went to Rio Tinto (Zimbabwe) Ltd. at Eiffel Flats, and some went to Anglo American Corp.-managed BSR Ltd. at Bindura. The BCL production facilities, about 350 kilometers northeast of Gaborone, consisted of the Selebi and Phikwe underground mines, and a processing complex 4 kilometers from the Phikwe shaft, which included a froth flotation concentrator facility and a coal-fired flash smelter and converter facility. BCL was reportedly owned by the Government of Botswana (15%) and Botswana RST Ltd. (85%). The latter's major shareholders apparently were AMAX Inc. of the United States and Anglo American Corp. (AAC) of South Africa each with 29.8% in 1987, the latest year for which ownership data were available.

Overall matte content for 1988 was near the considered typical average of about 40% each for nickel and copper with about 0.5% cobalt, under 20% sulfur, and under 1.5% iron. However,

cobalt content had been lower for the previous several years. Apparently, sulfur content in some converter product was adjusted, from about 19% to 6%, to provide total metal content of about 78% to 93%, respectively, depending on the customer's needs. Smelter-converter recoveries appear to have averaged over 96% for nickel, over 91% for copper, and 21% for cobalt. The matte was obtained from a record 1.18 million tons of feed to the flash smelting furnace, which was overhauled in 1987 after a record 7-year campaign. The feed included carry-over concentrates from 1987, but the major portion came from 1988's new record of 3.33 million tons of ore milled. The mill-head grades were 0.78% nickel and 0.82% copper, which resulted in 742,684 tons of concentrate at 2.86% nickel and 3.44% copper for a recovery of 81.4% and 93.9%, respectively. However, production was not expected to set another record in 1989, especially since the concentrator was operating at maximum capacity. Concentrator expansion was considered because the smelter still had some excess capacity.

Ore production tonnage also was a record: Phikwe—2,529,984 tons at 0.83% nickel and 0.71% copper and Selebi—815,561 tons at 0.63% nickel and 1.16% copper. At Selebi, about 14 kilometers southwest of Phikwe, a shaft system to allow production below the 250-meter level was being developed. On the Selebi North deposit, midway between Selebi and Phikwe, detailed planning was in progress for mine development in 1989 and production in 1990. The planned 1,500 tons per day production by 200 employees was to replace some output from Phikwe where grades were expected to decline. Limited exploration drilling gathered more information on the Phikwe North and South zones. Mineral reserves were considered adequate for operating beyond the year 2000, based on geologic interpretations in 1982 that there was a very persistent folded ore horizon.

For Botswana RST (BRST), in 1988 as compared to 1987, the larger quantity of matte and the higher metal prices, plus a decline in value of local pula currency relative to the U.S. dollar, resulted in a more than tripled pula sales revenue, equivalent to $231.8 million. Even with local inflation, this produced a huge increase in operating profit, but after substantial allowances for deferred royalty and interest, and unrealized exchange losses, the result was a loss for the year. Nevertheless, substantial cash distributions reduced part of the large outstanding debt. Heavy debt, primarily to major shareholders, had been incurred since start of production in 1973, because of major plant modifications to improve metal recoveries, production rates, and environmental conditions, as well as other difficulties. One of the latter was continuing production in order to maintain employment, in face of low metal demand and prices. BRST stated it expected to repay all outstanding senior debt in 1989. AMAX apparently was no longer actively looking for a buyer of its interests, as it was in 1987.

Tati Nickel Mining Company (Pty.) Ltd. (Tati) was granted a mining lease on the Selkirk and Phoenix nickel-copper sulfide deposits, 25 kilometers east of Francistown. BCL entered into agreements to manage the operations and to toll smelt the output, which was to be trucked about 120 kilometers south to Phikwe. Reportedly, Selkirk reserves were 1.2 million tons at 2.4% nickel and 1.3% copper, and mine production was expected to be rich enough for direct charging into the BCL smelter. Phoenix reserves were said to be in excess of 2.9 million tons at 2% nickel and 0.8% copper. Production was to start at Selkirk in January 1989; planned rate was 60,000 tons of ore per year, about 5% of 1988's feed to BCL's smelter, which was not at capacity. A decision on starting the Phoenix was still being considered. Tati is reportedly owned 51% by a Swiss trading affiliate of RTZ Corp. identified as Centametall and 49% by a United Kingdom investment group identified as Morex. Apparently, the Government had not yet exercised its reportedly legal option on 15% to 25% ownership. Centametall was said to be involved in the ore purchasing and smelting-refining contracts as it also was on the 20% of BCL's matte refined by Rio Tinto in Zimbabwe.

Additional nickel sulfide occurrences were frequently reported in the platinum prospecting that continued in the Molopo Farm Complex, 200 to 400 kilometers west southwest of Gaborone.

**Platinum.**—Prospecting for platinum-group metals (PGM) continued in the Molopo Farms Complex. The Complex was astride the Molopo River border with the Republic of South Africa, 200 to 400 kilometers west-southwest of Gaborone. Reportedly the Botswana Geological Survey, with British Government assistance, found low grades of PGM in the Complex in the early 1980's. However, as far back as the mid-1970's, the complex had been seen to be similar to the Bushveld Igneous Complex, 400 kilometers or more to the east in the Republic of South Africa, and more recently was considered a possible outlier. The Bushveld Complex contained major platinum and chrome deposits.

Gold Fields of South Africa had reported in 1986 that substantial exploratory drilling was underway on a three-unit, 3,000-square-kilometer concession, and in 1987 that the search continued. In 1988, the company was reportedly on its second and last automatic time extension of a prospecting license issued in January 1984, and having to decide soon, was concentrating on one unit area.

Molopo Botswana, said to be a joint venture of Molopo Australia and Southern Prospecting International (SPI) of South Africa, was also reported active. Apparently, work was on a 2,000- or 3,000-square-kilometer concession, adjacent to Gold Fields', which in 1986 was reported to be held

by SPI and, in 1987, by Molopo Australia. The latter was reportedly a company formed by SPI and Paringa Mining and Exploration to raise funds for the work.

***Industrial Minerals.*—Clays.**—Construction of a brick factory by Makoro Brick & Tile Ltd. began south of Palapye, about 250 kilometers northeast of Gaborone. Production was expected to start in April 1989, with a capacity of 14,000 bricks per hour. Employment was planned to total 111 employees. Botswana Development Corp., a parastatal, was a 30% shareholder. Construction was started on another brick plant, owned by Agro Industrial Products Ltd., with production slated for April 1989.

A mining lease on clay deposits near Lobatse, about 75 kilometers south of Gaborone, was issued to Kwena Concrete Products Ltd. Reports said an almost $10 million investment was expected to produce 24 million brick units per year, including bricks and floor and roof tiles.

**Construction Materials.**—Fourteen quarries or pits were in operation as follows: 10 for crushed stone, 2 for sand, and 2 for lime. Stone and sand output was up about 50% but lime was down about one-third.

**Diamond.**—Production of diamonds again increased in volume and value to new highs, and further increases in both were planned for 1989. Other sources said a plateau was expected in 1990 at about 16.5 million carats. The only producer of record, De Beers Botswana Mining Company (Pty.) Ltd. (Debswana), reported the sales value increase was helped by an average price increase of 14.5% from April 1988. This was the second in less than a year. However, the company reported a decrease in net profit, because of added income in 1987 from the sale of a large stockpile that had accumulated over a number of years.

The production was from three open pit mines operated by Debswana, which was owned equally by the Botswana Government and De Beers Consolidated Mines Ltd. (De Beers) of South Africa or its subsidiaries. Debswana held a 5% share in De Beers since a 1987 agreement that involved selling the large Debswana stockpile of diamonds to De Beers and included granting Debswana the right to two seats on De Beer's board of directors. The seats were initially filled in November 1988 by Government officials. Production for the mines in 1988 is reported in table 5.

Botswana's long drought continued to cause more than usual concern over the normally limited water supply in the arid area. Between Orapa, about 375 kilometers north of Gaborone, and Letlhakane, about 40 kilometers southeast of Orapa, additional water well fields were being established. These would supplement the seasonal Boteti River flow that did not reach the supply dam for Orapa, which then had to rely on existing well fields. At Letlhakane, pit dewatering wells provided sufficient water. Modification to the diamond treatment plant at Letlhakane was completed early in 1988 enabling a 20% increase in feed rate. At Jwaneng, about 125 kilometers west of Gaborone, construction of a new recrush facility, reported to cost $110 million, began in mid-1988. Startup is scheduled for 1990. It was planned to increase diamond production by 30%, treating lower grade ore and tailings to permit extracting mostly smaller diamonds that were not otherwise economically recoverable. The plant was designed with a new De Beers technology referred to as interparticle crushing.

TABLE 5

**BOTSWANA: DIAMOND PRODUCTION IN 1988, BY MINE**

| Mine | Metric tons ore treated | Carats produced |
|---|---|---|
| Orapa | 7,258,000 | 5,566,212 |
| Letlhakane | 2,949,000 | 733,637 |
| Jwaneng | 5,783,000 | 8,929,510 |

Debswana totaled over 4,700 employees at yearend. Usually satisfactory labor relations were strained somewhat during the year by a protracted dispute with the Mine Worker's Union over the minimum wage for unskilled employees. At yearend, the Union was not satisfied with the Government arbiter's decision and applied for review by the High Court of Botswana.

A kimberlite prospect called Gope 25, some 350 kilometers northwest of Gaborone in the Kalahari Desert, continued to be investigated by a joint venture of De Beers and Falconbridge Exploration Botswana. Falconbridge apparently did the original work from 1981 to 1987. Three other kimberlite discoveries were drilled and considered too low grade to be worked. At Gope 25, a 150-meter shaft was sunk, and a bulk sample was to be obtained for testing. The top of the ore horizon is covered by about 100 meters of sand overburden.

Areas reportedly being explored by other companies were southeast of Letlhakane, north of Orapa in the Makgadikgadi salt pans, and southwest of Jwaneng in the Molopo Farms igneous complex. Ampal, a local company, was in a joint venture with Australian companies Kalahari Exploration, a subsidiary of Taurus Resources and Molopo Farms Complex Exploration. All three companies were reportedly new to the search in Botswana and apparently were working in the Molopo area. Seltrust Botswana Exploration also was reported to be active in an unidentified area.

**Gem Stones.**—Based on number of exploration permits, gem stones other than diamond were an active field for exploration; however, value of production was not significant. Agate, of several varieties, was said to be the major product.

**Soda Ash.**—Annual production of 300,000 tons of soda ash and up to 650,000 tons of salt was scheduled within 2 years after startup in March 1991 at latest, of a plant to treat the underground natural brines of Sua Pan. Saltcake (sodium sulfate) and potash (potassium chloride) particularly were mentioned as potential byproducts. The plant was planned to be on a split of higher ground in the occasionally flooded Makgadikgadi Depression, an inland drainage basin that encloses the deposit about 450 kilometers north of Gaborone. For more than 40 years, various entities had been involved in investigating and/or attempting to commercialize the enormous deposit covering more than 900 square kilometers and contained in unconsolidated sands overlain by clays.

In November 1988, agreements in principle were concluded and a mining lease issued to Soda Ash Botswana (Pty.) Ltd., owned 52% by a South African consortium effectively led by AECI Ltd. and 48% by a consortium headed by the Government of Botswana. AECI's subsidiary AECI Chlor-Alkali Plastics Ltd. was reported to actually hold 26.5%; the other 25.5% was split equally between AAC and its affiliate De Beers. Substantial interests in AECI and its subsidiary were said to be held ultimately by AAC and by Imperial Chemical Industries Ltd. (ICI) of the United Kingdom. The Government was reportedly hoping to reduce its share to 24%; conceivably, this could be cut to as low as 15%, the apparent customary ownership retained by the Government in mining ventures, if announced discussions with international financing agencies, as well as local private sector investors, were successful.

Markets in southern Africa, mostly in South Africa, were expected to absorb the production. Press reports stated that South Africa's 1988 requirement for soda ash was roughly 260,000 tons. More than one-half of that was imported from the United States, which represented almost 10% of U.S. exports, but still there was some concern over the vulnerability to U.S. anti-apartheid sanctions. Related to the venture was AECI's decision to cancel a synthetic soda ash project to use salt and limestone in South Africa, and South Africa's agreement to a 10% duty on soda ash imports, if needed, to protect the new industry. Botswana officials expected production to boost total export earnings by 10%.

Prior to the November agreements, the American Natural Soda Ash Corp. (ANSAC), international marketing agency for the six U.S. producers, acted vigorously to protect their South African market, which reportedly approached $20 million at yearend 1988. The U.S. Government was pressed to reconsider aid to Botswana; ANSAC claimed the venture would not be competitive in delivered price and thus was basically uneconomic, and any restrictions, such as quota or duty, were a breach of trade agreements. Obviously, Botswana and South Africa considered the project's benefits, respectively, local employment and a secure supply of raw material, were more important.

The project was expected to cost about $400 million. Financing announced was 35% equity; 24% South Africa and Botswana bank loans, some of which were guaranteed by De Beers; 27% South African credits; the remaining 14% was not fully arranged, but said to include the Federal Republic of Germany and Japanese credits. Reportedly, the Botswana Government also was to provide an infrastructure costing about $80 million and covering town, water, power, and a $40 million, 165-kilometer railroad from Francistown. Employment was projected at 540, including initially, 110 expatriates.

The processing facilities were said to be based on Kerr-McGee technology used in California for brines having the same chemistry. The planned process was described as starting with wells about 35 meters deep to supply brine for concentration in solar evaporation ponds covering about 25 square kilometers where most of the sodium chloride would crystallize. According to reports, a chemical plant would subsequently complete separation and purification of sodium carbonate from the remaining brine by carbonation, crystallization, filtration, and calcination. A consortium consisting of Uhde, a chemical plant constructor from the Federal Republic of Germany, and LTA Ltd., a South African process engineering-construction affiliate of AAC, was reportedly appointed principal contractor. Babcock Engineering of South Africa was reportedly to supply two boilers to be fired by Botswana coal. Environmental protection was especially mentioned as being carefully considered during design and construction, based on a 1985 impact assessment.

***Mineral Fuels.*—Coal.**—The Morupule Mine, about 250 kilometers north-northwest of Gaborone and 15 kilometers west of Palapye, continued to expand production to meet increased power demand, as it has every year except 1983 and 1984, since startup in 1973. The operating company, Morupule Colliery Ltd., reportedly over 90% owned by AAC or affiliates, originally opened the mine to supply the smelter and power station at the Selebi-Phikwe nickel-copper mines. Soon afterward, Botswana Power Corp. began purchasing some output and eventually become the major customer. In 1988, substantial expansion plans were reported for supplying needs for power and heat at several new projects, including the Sua Pan soda ash and Jwaneng developments.

A shallow, underground stop adit operation, Morupule was the only mine exploiting Botswana's coal reserves which are reportedly the largest on the continent after South Africa.

Since coal was first reported before 1900, there have been numerous investigations, including fairly extensive field exploration programs. In the last decade, estimates have ranged from at least 3.5 billion tons of economically recoverable coal plus at least 13 billion tons indicated reserves, to 40 billion

tons called identified resources. Although coal was reported over a large area, the apparently better coal was at Moropule and Mmamabula, about 130 kilometers south. Medium ash, medium calorie grades, were said to extend some 50 kilometers west from Morupule, with poor quality seams continuing southwesterly. Three seams were considered economically significant; the lowermost, Morupule Main, was about 9 meters thick where it was mined. The Mmamabula area coal was said to be lower grade than at Morupule and to have seams broken by faults.

Periodically, studies apparently found that the lack of abundant water needed for beneficiation as well as high transportation costs mitigated against developing an export market.

A campaign to increase utilization of coal as fuel in households as well as in industry and commerce was continued from 1987. This effort, supported by the Federal Republic of Germany, is particularly aimed at replacing the use of wood, which was becoming very scarce.

**Petroleum.**—The search continued into Botswana's oil and gas potential, which generally is considered to be in the western Kalahari. Oil seeps were long known to be across the border in Namibia. Aerial surveys, reportedly starting with magnetics funded by Canada in the 1970's, and subsequent ground and aerial work apparently continued to justify further exploration into 1989. In 1988, Petro Canada reportedly completed an encouraging program. This apparently was seismic work that started in 1986 and covered the Nossop, Ncojane, and Passarge Basins, three deep sedimentary basins (to 15,000 meters) previously outlined by studies as potential hydrocarbon sources. Two other firms, one from the Federal Republic of Germany and one from France or Belgium were reportedly also interpreting that data and/or previous data, and one firm reportedly was possibly doing ground work.

Early in 1989, a news release stated that Petro Canada International Assistance Corp. had confirmed it would drill a hole up to 4,000 meters deep, which other reports said was for stratigraphic information.

## LESOTHO[4]

Since the closure of the Letsengla-Terai mine in 1982, Lesotho's mineral production has consisted solely of sand and gravel for local use. The most significant new development in the Lesotho economy was the final approval of the Highlands Water Project. This $2 billion project will involve the construction of four dams, one of which, the Katse dam, reportedly will be the largest in sub-Saharan Africa. The purpose of the project is to provide water to the Republic of South Africa and electricity to both Lesotho and the Republic of South Africa.

Tenders began in 1988 for various phases of the project, including numerous roads into previously inaccessible regions of the country. Construction of some of these roads was in progress during the year. The Katse Dam was slated for completion by late 1995; the remaining three dams and two transfer tunnels would be completed over the following 25 years. The project's hydropower delivery was to be 100 megawatts at full capacity. Annual revenues from water sales to the Republic of South Africa are anticipated to be between $20 million and $50 million.[5] Large additional revenues were anticipated from recreational use of the project's reservoirs. Road and dam construction was expected to require a major increase in the country's production of sand and gravel and other construction materials.

A major factor in the economy continued to be the repatriated wages of the approximately 120,000 Basotho mineworkers in the Republic of South Africa. Of these, about 101,000 were employed in gold mines and 6,700 in coal mines. These mineworkers represented about 7% of Lesotho's population. Estimates of their wages in 1988 ranged from $295 million to $315 million, or about 40% of the country's GNP.

## MALAWI[6]

The mining industry consisted mostly of coal, limestone for cement production, crushed stone for construction, and clays for brickmaking. Small quantities of gem stones were reported to have been mined at Chimwadzulu in central Malawi. Although Malawi has significant quantities of industrial minerals, little was known of the deposits other than estimates of geologic reserves. Exploration of these deposits was planned by the Malawi Geologic Survey with French technical

TABLE 6

**LESOTHO: PRODUCTION OF MINERAL COMMODITIES[1]**

| Commodity | | 1984 | 1985 | 1986 | 1987[p] | 1988[e] |
|---|---|---|---|---|---|---|
| LESOTHO[2] | | | | | | |
| Stone[e] | cubic meters | 25,000 | 25,000 | 25,000 | 25,000 | 50,000 |

[e] Estimated [p] Preliminary.

[1] Includes data available through Feb. 20, 1990.

[2] In addition to the commodity listed, modest quantities of unlisted varieties of crude construction materials (clays, sand and gravel) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

TABLE 7

**MALAWI: PRODUCTION OF MINERAL COMMODITIES[1]**

(Metric tons unless otherwise specified)

| Commodity[2] | 1984 | 1985 | 1986 | 1987[p] | 1988[e] |
|---|---|---|---|---|---|
| Cement, hydraulic | 70,058 | 61,654 | 69,471 | 72,831 | [3]65,597 |
| Coal | 2,000 | [e]4,000 | 10,708 | 18,256 | [3]39,376 |
| Lime | 2,005 | 1,923 | 2,735 | 2,160 | 3,000 |
| Stone: Limestone for cement | [e]100,000 | [e]100,000 | 103,037 | 107,040 | 105,000 |

[e]Estimated. [p]Preliminary.

[1]Includes data available through Feb. 20, 1990.

[2]In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, sand and gravel) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

[3]Reported figure.

support.

The Malawian economy was predominately agricultural, and about 90% of the population lived in rural areas. Agriculture accounted for 40% of GDP and 90% of export revenues. The industrial base is small, and nearly all essential needs are imported.

There were very few metalliferous mineral deposits known in Malawi. The two most promising were the Kayelkera uranium deposit in the northern part and the Kanunghunde Hill rare-earth deposit in the southern part of Malawi. Both deposits were undergoing prefeasibility studies.

Malawi's Kaziwiziwi and Mchenga coal mines produced over 26,000 tons of subbituminous coal in 1988, over 60% of total demand. However, known reserves at these mines were considered only sufficient to last another 3 to 5 years. Consequently, French-sponsored exploration of coal occurrences in the southern region was increased. Mobil Oil Corp. and the Government were to enter into negotiations in 1989 regarding a long-term petroleum exploration program in the Lower Shire Valley and Lake Malawi area. Malawi imported all of its petroleum products.

## MOZAMBIQUE[7]

The overall level of exploration activity in Mozambique increased in 1988, especially for gold, titanium sands, coal, and graphite. Several mines in Zambezia Province, which had once produced tantalum minerals and gem stones from pegmatites and had been overrun by insurgents in 1986, were secured by the Government in 1988 and were undergoing rehabilitation studies at yearend. Overall foreign investment in the mining sector increased from about $500,000 in 1986 to about $2 million in 1988 and was expected to reach $5 million in 1989 and about $12 million[8] in 1990.

Production of most mineral commodities decreased, although bauxite production increased significantly. Mining was the key sector in the Government's program to attract new foreign investment. Agreements were being negotiated with a number of foreign companies and governments for the exploration and mining of such commodities as coal, gold, bauxite, copper, titanium sands, graphite, clay, diatomite, tantalite, gem stones, petroleum, and natural gas. In addition, the Government received and was negotiating numerous loans and other assistance, largely related to the purchase of food and fuel, and the rehabilitation of the country's transportation infrastructure.

The continuing insurgency affected all sectors of the Mozambique economy, but had its greatest effects in the displacement of a large sector of the population and in the disruption of the country's transportation infrastructure. This in turn greatly affected Mozambique's agricultural output and its ability to transship goods from neighboring countries and to transport for export its own mining products, most notably coal. Rail traffic along certain routes increased owing to ongoing rehabilitation to the rail lines and the protection offered by the presence of foreign troops. The ports of Beira and Maputo were undergoing various forms of rehabilitation during the year, but shipping capacities at both remained well below levels reached in years before the onset of guerrilla attacks. The giant Cahora Bassa hydroelectric facility remained inoperative owing to insurgent attacks on the power transmission pylons.

In 1988, Mozambique's GDP increased 4% to about $1.6 billion; however, this was well below the $4.13 billion GDP in 1986. Mineral exports declined in value by 1% to about $1 million, which represented about 1% of the country's total exports. Mozambique's total imports increased 25% to about $765 million, of which fuel imports comprised about $70 million. Imports from the Republic of South Africa were in excess of $75 million. Although mining in Mozambique was only a small factor in the overall economy, it was the sector that was being most heavily promoted as having the greatest potential for significant expansion. Furthermore, a major proportion of the country's foreign exchange earn-

ings was by the transshipment of goods, largely coal, ferrochrome, and copper, from the Republic of South Africa, Swaziland, Zimbabwe, and Zambia, and of fuel and other commodities into some of these countries. In addition, Mozambique benefited from an estimated $108 million in wages earned by its 47,000 workers employed in mines in the Republic of South Africa.[9]

Traditionally, a large proportion of Mozambique's revenues have been earned through the transshipment of goods to and from other countries in the region. In terms of distance, export via Mozambique ports is cheaper than exports through other countries such as the Republic of South Africa. It was estimated that Zimbabwe saved $35 million in 1988 using Mozambique ports. Regional exports through Mozambique were via four main rail lines: the so-called Limpopo Corridor connecting the Eastern Transvaal, Republic of South Africa, with Maputo; a rail line from Swaziland to Maputo; the so-called Beira Corridor, connecting Beira to Zimbabwe; and the rail line from Nacala to Malawi. All of these lines had been partly or completely interrupted by insurgent activity, and all came under attack in 1988. The Limpopo Corridor and Nacala route were inoperative during the year, but both the line to Swaziland and the Beira Corridor were operational, if only intermittently. All of the routes were undergoing rehabilitation during the year. In addition, a reported 10,000 Zimbabwean troops were guarding the vital Beira Corridor, and, to a lesser extent, the rehabilitation work on the Limpopo Corridor. A reported 600 Malawian troops were helping to secure the rail line to Nacala.

While overall revenues from domestic rail traffic increased, international transit revenues decreased, because of a 19% decrease in shipments from the Republic of South Africa. International shipments along the Beira Corridor increased, however, owing to both improvements in the line and the fact that Zambia shipped about 10% more copper than normal to Beira because of problems with shipments to Dar es Salaam, Tanzania. Overall traffic through the port of Beira increased 13% to 2.2 million tons.

Rehabilitation of the Beira Corridor was part of an ongoing $350 million project for which the Government continued to negotiate grants and loans. A number of regional and Western governments and financial institutions were involved with this project, as well as with less advanced projects on the other routes. Improvements to the port of Beira included harbor-dredging, funded by the Netherlands, that would allow ships of 60,000 tons displacement to dock and the construction of new loading facilities financed by Sweden. The Republic of South Africa was rehabilitating the coal-loading terminal at Maputo, while Norway financed the rehabilitation of the coastal shipping berth there. Canadian and Italian funding was being used to reroute, for security reasons, the Cahora Bassa transmission lines closer to the Beira Corridor.

Mozambique's bauxite production was restricted to a small operation in Manica Province close to the Zimbabwe border. Production of bauxite, grading 60% aluminum oxide, increased 28%. As in past years, the bauxite was exported to Zimbabwe. Bauxite reserves in the region were being delineated by the United Nations Development Program.

Guerrilla-inflicted damage to the railroad to the Moatize coal mines severely limited the ability of the mines to economically ship production, which consequently fell almost 45%. Total coal shipments, which were mostly by truck, were estimated to be approximately 107,000 tons; this amount was believed to include material in stockpile at yearend 1987. Coal exports were largely to Malawi. Brazil's parastatal mining company, Cia. Vale do Rio Doce, was exploring for coal in the Moatize region and was planning to assist in the rehabilitation of some of the coal mines.

Lonrho PLC of the United Kingdom continued its exploration efforts for lode and placer deposits in Manica Province, close to the company's gold mine at Penhalonga, Zimbabwe. Feasibility studies were expected to be carried out on several prospects in 1989. The company was also exploring for gold in the southwest part of the country. Mozambique reported the production of about 23,000 troy ounces of silver, presumably as a byproduct of the country's modest copper production.

Production of tantalum minerals ceased in 1986 when the producing mines in the Mocuba and Alto Ligonha region were overrun by insurgents. This area was secured by the Government in 1988, but the mines were discovered to have been severely damaged by the insurgents. The Government was seeking overseas investors to rehabilitate the mines. In recent years prior to the insurgent attacks, tantalum mineral production had been from the Morrua, Muiane, and Marropino Mines, for which the reported installed production capacities are given in table 9. Annual production in the 1980's was well below listed capacity, which in turn appeared to be below production levels of the 1970's.

More recent reports speculate that the tantalite output capacity of Morrua is 62.5 tons per year, with the possibility of being expanded to 153 tons per year.

Kenmare Resources Plc. of Ireland continued drill testing of its titanium sands deposit near Angoche. An independent consultant study of the project by Mineral Deposits Ltd. of Australia was begun late in the year and was expected to be completed by mid-1989. Preliminary results, based on a 2,000- to 2,500-ton-per-hour dredge-operation mine plan, gave proven reserves as 123 million tons grading 3.9% heavy minerals, up from the 1987 speculative reserves of 28 million tons grading 8% heavy minerals. The ilmenite-dominated deposit remained to be delineated at both ends and at depth. Kenmare was testing the deposit below the water table and predicted that the final reserves would be well in

TABLE 8

## MOZAMBIQUE: PRODUCTION OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

| Commodity[2] | | 1984 | 1985 | 1986 | 1987[p] | 1988[e] |
|---|---|---|---|---|---|---|
| Asbestos | | [e]400 | 55 | — | — | — |
| Bauxite | | — | 5,037 | 4,247 | 5,113 | [3]6,548 |
| Beryllium: Beryl concentrate, gross weight | | 7 | 6 | 1 | — | — |
| Bismuth: Bismuth minerals | kilograms | 1,047 | 1,052 | 80 | — | — |
| Cement, hydraulic | thousand tons | [r]110 | [r e]200 | [r e]200 | [r e]250 | 400 |
| Clays: | | | | | | |
| Bentonite | | 405 | 361 | 1,112 | 936 | [3]986 |
| Kaolin | | [e]300 | 152 | 230 | 151 | 200 |
| Coal, bituminous | thousand tons | 107 | 20 | 4 | 43 | [3]24 |
| Copper, mine output, salable ore and concentrate: | | | | | | |
| Gross weight | | 1,573 | 590 | 1,303 | 719 | [3]660 |
| Cu content | | 291 | 118 | 260 | 151 | [3]139 |
| Feldspar | | [e]800 | 67 | 100 | — | — |
| Gem stone: | | | | | | |
| Cut stones, all types | carats | NA | NA | 35,477 | 36,340 | [3]26,551 |
| Aquamarine | grams | 2,400 | 3,600 | 568 | — | — |
| Beryl, morganite | do. | 96 | 50 | 7,303 | — | — |
| Emerald | do. | 4,200 | 5,000 | [e]5,000 | — | — |
| Garnet | kilograms | 1,625 | [r]2,000 | 11,024 | 13,240 | [3]17,860 |
| Tourmaline | grams | 6,000 | 1,500 | 4,231 | — | — |
| Lime, hydraulic[e] | | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Marble | cubic meters | 575 | 715 | 1,137 | 1,140 | [3]940 |
| Mica, waste[e] | | 300 | 300 | 300 | — | — |
| Monazite concentrate[e] | kilograms | 4,000 | 4,000 | 2,649 | — | — |
| Ornamental stones, rose quartz | do. | 3,600 | 2,500 | 2,500 | 2,500 | 2,500 |
| Petroleum refinery products: | | | | | | |
| Gasoline | thousand 42-gallon barrels | 140 | — | — | — | — |
| Kerosene and jet fuel | do. | 23 | — | — | — | — |
| Distillate fuel oil | do. | 160 | — | — | — | — |
| Residual fuel oil | do. | 487 | — | — | — | — |
| Asphalt | do. | 25 | — | — | — | — |
| **Total** | **do.** | **835** | **—** | **—** | **—** | **—** |
| Salt, marine[e] | | 28,000 | 28,000 | 28,000 | 28,000 | 28,000 |
| Tantalum ores and concentrates: | | | | | | |
| Microlite | kilograms | 9,900 | 6,283 | 2,649 | — | — |
| Tantalite | do. | 6,700 | 4,275 | [r]5,373 | — | — |

[e] Estimated. [p] Preliminary. [r] Revised. NA Not available.

[1] Data available through Feb. 20, 1990.

[2] In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, sand and gravel, and stone) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

[3] Reported figure.

TABLE 9

**MOZAMBIQUE: INSTALLED TANTALUM MINERAL PRODUCTION CAPACITY**

(Production in metric tons, grade in percent $Ta_2O_5$)

| Mine | Microlite | | Tantalite | |
|---|---|---|---|---|
| | Production | Grade | Production | Grade |
| Morrua | 31.3 | 65 | 29.3 | 50 |
| Muiane | 10.7 | 67 | 14.5 | 31 |
| Marropino | 19.3 | 55 | 8.8 | 27 |

Source: Exploration and mining activities report for 1984. Mozambique Ministry of Mineral Resources.

excess of those announced. Given satisfactory results of the 1989 drilling program, it was anticipated that mining would begin in mid-1991.

Edlow Resources, a Bermuda-registered American company, completed phase I drilling of its Pebane titanium sand concession immediately to the south of Kenmare's Angoche property. The drill program tested, at a reconnaissance level, approximately 120 kilometers of a 200-kilometer strip between the Riara and Moma Rivers. The drilling was by hand auger to a maximum depth of 20 meters and was conducted on lines extending 5 kilometers inland, spaced 10 kilometers apart. The results were particularly encouraging for the portion of the concession lying between the Morenja River and Pebane, although the preliminary reserve estimates were not available. The company planned to do intermediate-scale phase II infill drilling in this area in 1989. Toward yearend, Edlow was negotiating with the Government for exploration and mining rights to the Quelimane concession, which adjoins the south end of the Pebane concession.

The Ministry of Mineral Resources received a loan from the Italian Government for the expansion of existing marble quarries at Montepuez in Cabo Delgado Province and for setting up a cutting and polishing plant for production. The Italian company Technostone S.p.A. had the construction and technical contract for this project.

Geologic studies, begun in 1987, identified several deposits of graphite in gneisses in the Ancuabe area of Cabo Delgado Province. During 1988, further work was done on one of these deposits, resulting in the delineation of reserves of 20 million tons, grading 4.75% graphite. A preliminary feasibility study was prepared, and the Government was seeking private investors to develop the deposit.

Marwais Steel of the United States was studying the feasibility of assuming operation of the state-owned wire and rod mill near Maputo, which was operating at only about 10% capacity.

## NAMIBIA[10]

The mining industry continued to be the major source of foreign exchange in 1988, accounting for about 85% of total exports. Production of most mineral commodities was up or similar to that for 1987, and interest in exploration increased. Implementation of an agreement among Angola, Cuba, and the Republic of South Africa began a process aimed at achieving national independence for Namibia.

The GDP was $1,538 million[11] in 1987, the latest year for which detailed statistics were available. Mining accounted for 24.9% of the GDP, compared with 22% for general Government, 12% for agriculture, 12% for wholesale and retail trade, and 7% for transport and communications. The mining sector made up almost 37% of total private sector contribution to the GDP. Total exports in 1987 were $889 million compared with $878 million in 1986, while the value of mineral exports was down by about 20% in that time period.

Government expenditures for the financial year ending March 31, 1989, were projected to be $860 million, an increase of 2.7% over 1988. The deficit was estimated at $343 million in that time period. The Republic of South Africa budgeted $136 million for Namibia's economy in 1988, and a similar amount was scheduled for 1989. No loans were made by the Government in 1986 and 1987, but such borrowing may constitute 5% of the GDP in future years. Combined direct taxes paid by mining companies, which were members of the Chamber of Mines (CM) in 1987, were $138 million or about 25% of total public revenue collected, and indirect taxes were $16 million. In 1987, the latest year available, the mining industry had capital expenditures of $46.4 million, and operating profit, minus depreciation, was $234.8 million, compared with $32.7 million and $343 million, respectively, in 1986.

Exploration expenditures in 1988 were a record $17 million, compared with $10 million in 1987. The Department of Economic Affairs issued 229 new prospecting licenses, compared with 197 in 1987. New claims registered jumped from 580 to 1,670, while there were 10 new prospecting grants compared with 29 in 1987. Of prime exploration interest were diamonds, precious and base metals, and granite and marble.

The total labor force of mines that were members of the CM was 13,073, compared with 12,905 in 1987. Remuneration to these workers, including cash and fringe benefits, was $110 million or 14.3% of total employee remuneration for the country. A total of 39 people were injured in mine accidents, giving a reportable injury rate of 2.98 per 1,000 workers. Total fatalities in the

mining sector were 7, giving a fatality rate of 0.54 per 1,000 workers.

Gold Fields of South Africa Ltd. (GFSA) took over Newmont Mining Corp.'s 31% share of Tsumeb Corp. Ltd. (TCL) in early 1988. GFSA restructured its interests in Namibia by forming Gold Fields Namibia Ltd. (GFN), in Windhoek. GFSA held 69% of GFN; Seltrust Investments Ltd., 8.3%; BP Minerals Development Ltd., 3.5%; Southern Life Association Ltd., 6%; and General Mining Union Corp., 3.7%. GFN held 100% of Berg Aukas Ltd., Gold Fields Prospecting Co. (Pty.) Ltd., Namib Mines Ltd., Trekkopje Exploration and Mining Co. Ltd., TCL, and Tsumeb Exploration Co. Ltd. (TECO). In the 18-month period ending December 1988, GFN spent $3.4 million on exploration. The company also changed its financial yearend to December 31 from June 30.

### Government Policies and Programs

Rossing Uranium Ltd., in cooperation with the Department of Water Affairs, was undertaking research to replenish underground water supplies through the intermittent damming of the perennial Khan River. Rossing obtained 90% of its water supply from the Kuiseb and Omaruru Rivers. Water availability was a major issue in certain areas of Namibia, and results of the $44,200 program may be viable elsewhere.

### Production and Trade

Revenue accrued from Namibia's membership in the Southern African Customs Union was $193 million in 1987, the latest year available, compared with $154 million in 1986. Owing to overwhelming size of the economy of neighboring Republic of South Africa, Namibia's currency, manufacturing, and industrial base will continue to be dependent upon that country.

Several major well-established South African companies were investing $53 million in construction projects in Windhoek. Consolidated Mines (Pty.) Ltd. (CDM) opened its $13 million sorting and valuation facility in Windhoek under CSO Valuations Namibia (Valco). Output from Namibia had been shipped to the Republic of South Africa for sorting and valuation in Kimberley by a subsidiary of De Beers Consolidated Mines Ltd.

### Commodity Review

***Metals.*—Copper.**—As of January 1, 1988, TCL, the largest copper producer in Namibia, became a wholly owned subsidiary of GFN, and a portion of GFN's shares was listed on the Johannesburg Stock Exchange in October. In addition, TCL acquired all assets and liabilities of TECO. GFN's profits after taxes for the year ending December 31, 1988, were $25.4 million, compared with $10 million in 1987.

The Asis West section of the Kombat Mine, owned by GFN, was closed at yearend following flooding on November 8, 1988, that killed seven workers. The section was expected to remain closed in 1989. Work to repair flood damage included the installation of a concrete plug to seal the ruptured fissure, with total recovery cost estimated at $6.6 million. Mill activity was maintained at about one-third of capacity by treating surface dumps and some shallow ore, as well as expanding output from the Asis Est section of the mine to 10,000 tons per month. Output at the Tsumeb and Otjihase Mines was also to be expanded to make up for the shortfall from the Kombat Mine, using men and equipment from Kombat. Prior to the flooding, ore recovery at Kombat was 100% using cut-and-fill stoping. Total cemented backfill to the Tsumeb and Kombat Mines was 461,576 tons for a consumption of 23,294 tons of cement.

At the Tsumeb Mine, deep-level exploration was underway, as was evaluation of nearby deposits for extending mine life beyond the 7 years of reserves currently known.

At the Otjihase Mine, TCL encountered low efficiency and numerous maintenance problems from its recent implementation of an underground crushing and pumping system, with only about 300 tons per day of ore reaching the surface at high cost. TCL hoped to return to a system of ore passes and haulage to overcome the problem. In the Oblique block, site of most ore output, geological conditions and ore-body depth resulted in a denser rock-bolting pattern and larger support pillar size. Pillar reclamation amounted to 2% of total production. Mine development work was also being restricted by a lower availability of drill rigs and production also suffered because of high operator absenteeism for the roof-bolting rig.

Copper reserves for TCL, as of December 31, 1988, were 13.8 million tons averaging 2.75% copper. Of the company's total reserves, 3.2 million tons averaging 3.53% copper was at Tsumeb Mine; 3.3 million tons averaging 2.86% copper was at Kombat Mine; and 7.2 million tons averaging 2.35% copper was at Otjihase Mine.

Uncertainty in the political future of Namibia was believed to be responsible for a labor turnover of 14% in 1988, compared with 8% in 1987. At yearend, total employment was 3,996. The Mineworkers Union of Namibia (MUN) was granted an extended period of access to TCL's employees for further recruitment, while the South West Africa Mine Workers' Union gained recognition in June for the skilled category of workers at TCL's mines.

**Gold.**—Work on AAC's Navachab Mine continued with the awarding of a $2.5 million contract to Ovcon Civil Corp. for construction of a cement facility at the mine. Erongo Mining and Exploration Co., a subsidiary of AAC, was overseeing construction of the site and mine. It was to be an opencast mine with production of 14,000 tons of ore per week, and gold recovery would be by carbon-in-pulp and cyanidation. Site equipment would include a 1-kilometer-long conveyor feeding a

TABLE 10

## NAMIBIA: PRODUCTION OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

| Commodity[2] | 1984 | 1985 | 1986 | 1987[p] | 1988[e] |
|---|---|---|---|---|---|
| METALS | | | | | |
| Antimony, Sb content of sodium antimonate | — | — | — | 32 | [3]98 |
| Arsenic, white | 2,504 | 2,471 | 2,208 | 1,864 | [3]2,983 |
| Cadmium metal, refined | 40 | 58 | 61 | 51 | [3]106 |
| Columbium and tantalum: Tantalite concentrate, gross weight kilograms | ᵣ5,115 | ᵣ3,113 | 8,186 | 13,809 | 15,000 |
| Copper: | | | | | |
| Mine output, Cu content of concentrate | 47,406 | 48,036 | 49,591 | 37,557 | 40,000 |
| Metal, blister | 46,436 | 43,295 | 45,688 | 35,488 | [3]39,970 |
| Gold, Au content of smelter products troy ounces | 6,302 | 6,237 | 5,916 | 5,530 | [3]6,269 |
| Lead: | | | | | |
| Mine output, Pb content of concentrate | 33,255 | 34,640 | 37,494 | 32,997 | 37,200 |
| Metal, refined | 28,930 | 38,511 | 40,047 | 40,634 | [3]44,447 |
| Silver, mine output, Ag content of concentrate thousand troy ounces | 3,255 | 3,404 | 3,457 | 3,320 | 3,300 |
| Tin, mine output, Sn content of concentrate | 906 | 984 | 880 | 1,097 | 1,182 |
| Uranium, $U_3O_8$ content of concentrate | 4,400 | 4,400 | 3,990 | 4,175 | 4,100 |
| Zinc, mine output, Zn content of concentrate | 32,195 | ᵣ30,332 | 35,371 | 39,650 | 36,000 |
| INDUSTRIAL MINERALS | | | | | |
| Diamond: | | | | | |
| Gem[e] thousand carats | 884 | 865 | 970 | 970 | 890 |
| Industrial[e] do. | 46 | 45 | 40 | 50 | 48 |
| **Total do.** | **930** | **910** | **1,010** | **1,020** | **[3]938** |
| Granite | NA | NA | 71 | 730 | 1,000 |
| Limestone and marble | ᵣ23,464 | ᵣ35,209 | 33,829 | [e]32,000 | 35,000 |
| Lithium minerals: | | | | | |
| Amblygonite | ᵣ58 | ᵣ49 | 52 | 106 | [3]147 |
| Lepidolite | ᵣ18 | ᵣ71 | 52 | 61 | [3]18 |
| Petalite | ᵣ829 | ᵣ1,763 | 751 | 749 | [3]1,477 |
| **Total** | **ᵣ905** | **ᵣ1,873** | **855** | **916** | **[3]1,642** |
| Mica | ᵣ87 | — | — | — | — |
| Quartz | 20 | 300 | 851 | 2,273 | [3]— |
| Salt | ᵣ88,376 | ᵣ153,447 | 134,644 | 125,031 | 125,387 |
| Semiprecious stones: | | | | | |
| Agate | 41 | 65 | ᵣ87 | 100 | 100 |
| Amethyst | 105 | 21 | 37 | 189 | 200 |
| Beryl | 4 | 2 | 4 | 1 | — |
| Chrysocolla kilograms | NA | NA | 1,000 | 8,250 | 8,200 |
| Dioptase do. | NA | NA | 520 | 60 | 60 |
| Rose quartz | 369 | 299 | 172 | 365 | 370 |
| Sodalite | — | 140 | NA | — | 100 |
| Tourmaline kilograms | 306 | 745 | 2,878 | 1,709 | 1,700 |
| Silica: | | | | | |
| High-purity | 57 | 946 | 1,041 | 2,190 | 2,100 |
| For flux | 1,025 | 645 | 5,918 | [e]6,000 | 6,000 |
| Sulfur, S content of pyrite concentrate | 104,454 | 107,718 | 133,824 | 74,354 | 75,000 |
| Wollastonite | — | 373 | 601 | 500 | 500 |

[e] Estimated [p] Preliminary ᵣ Revised NA Not available

[1] Table includes data through June 22, 1989.

[2] Data are compiled from the annual report of the Chamber of Mines of South West Africa-Namibia, and from operating company annual reports as follows: Tsumeb Corp. Ltd. (TCL), South African Iron and Steel Corp. Ltd., Gold Fields Namibia Ltd., De Beers Consolidated Mines Ltd., and others as available.

[3] Reported figure.

2,400-cubic-meter silo, a mill feed conveyor, a leach plant with seven leach tanks, an adsorption plant with seven tanks, an elution and regeneration area, and smelting facilities. Water supply would be from the Swakkoppoort Dam via an 85-kilometer-long pipeline. Total capital cost was $39.4 million, and mine life was about 13 years with initial ore reserves of 10.1 million tons averaging 0.07 troy ounce per ton. Total employment would be about 200. Initial output was planned for October 1989, and full production was planned for March 1990.

GFN has a gold prospect in the Ondundu area with an estimated 4.5 million tons of ore averaging 0.12 troy ounce per ton.

Remny Corp. of the United States signed a $1.5 million contract for gold mining rights in Rehoboth.

**Lead.**—Total refinery capacity was about 70,000 tons per year. Output of refined lead at TCL's smelter was 14,428 tons from TCL's mines and 30,019 tons from other sources. About 65,000 tons in concentrates was purchased from other sources, including Australia and Ireland.

Small ore bodies in the vicinity of the Kombat Mine, some mined previously, were being considered for exploitation. An abandoned mine near Gross Otavi, about 15 kilometers west of Kombat, was expected to produce 5,000 to 10,000 tons per year of ore for processing at Kombat.

**Tantalum.**—Severin Mining and Development Co. (Sevmin) of the Republic of South Africa was proceeding with plans to produce tantalum from a deposit 50 kilometers north of the Orange River in southern Namibia. The 40,000-acre site, which straddles both sides of the Orange River, was purchased by Sevmin from Utah Mining Co. of the United States in 1986.

**Tin.**—Imcor Tin (Pty.) Ltd., 100% owned by the Iron and Steel Corp. of South Africa (Iscor), had an $80,000 program underway to automate the tertiary crushing system at the Uis Mine. Implementation of the system will permit two crushers to replace the throughput capacity of the four crushers now used. The privatization of Iscor was expected to provide for the sale of Imcor shares to the public by about October 1989. Sale preference would be to company employees, including 550 self-employed Damara miners operating adjacent to the Uis Mine. About 90% of the tin required for electroplating at Iscor's Vanderbijlpark plant was obtained from the Uis Mine, where ore grade was about 0.139% tin.

GFN reported the discovery of about 1 million ton of ore grading 1.45% tin at Goantagab.

**Zinc.**—Imcor Zinc (Pty.) Ltd., which operates the Rosh Pinah Mine, was 51% owned by Iscor and 49% owned by Moly-Copper Co. About 70,000 tons per year of zinc concentrate was shipped to Zinc Corp. of South Africa Ltd. near

TABLE 11

**NAMIBIA: GROSS WEIGHT AND ELEMENTAL CONTENT OF ORE AND CONCENTRATE PRODUCED IN 1988, BY MINE**

(Metric tons unless otherwise specified)

| Mine or mill | Gross weight | Elemental content | | | | |
|---|---|---|---|---|---|---|
| | | Copper | Lead | Zinc | Sulfur | Silver (troy ounces) |
| Kombat: | | | | | | |
| Ore | 350,689 | 10,833 | 3,629 | — | NA | 270,066 |
| Concentrate: | | | | | | |
| Copper | 33,933 | 9,716 | 2,788 | — | NA | 245,889 |
| Lead | 1,701 | | | | | |
| Otjihase: | | | | | | |
| Ore | 831,570 | 16,016 | — | — | e154,200 | 149,372 |
| Concentrate: | | | | | | |
| Copper | 55,789 | 15,148 | — | — | e19,300 | 115,968 |
| Pyrite | 226,682 | | — | — | e115,200 | — |
| Rosh Pinah: | | | | | | |
| Ore e | NA | — | 14,000 | 37,800 | NA | NA |
| Concentrate: | | | | | | |
| Lead | 20,627 | — | 8,881 | e950 | NA | 835,918 |
| Zinc | 65,281 | — | e4,300 | 34,194 | NA | e595,000 |
| Slag mill: | | | | | | |
| Ore (slag) | 229,200 | 2,642 | NA | — | NA | 68,063 |
| Concentrate | NA | 1,100 | 403 | — | NA | 46,040 |
| Tsumeb: | | | | | | |
| Ore | 620,906 | 17,228 | 19,189 | e7,100 | NA | 2,168,082 |
| Concentrate: | | | | | | |
| Copper | e110,000 | 14,928 | 15,716 | e2,500 | NA | 1,907,372 |
| Lead | | | | | | |
| **Total:** | | | | | | |
| Ore | XX | 46,719 | 36,818 | 44,900 | e154,200 | NA |
| Concentrate | XX | 40,892 | 32,088 | 36,694 | e134,500 | 3,746,187 |

eEstimated NA Not available XX Not applicable

Springs, Republic of South Africa, for refining and shipping to Iscor's Vanderbijlpark plant. Milling capacity was about 600,000 tons per year, and mine life was about 15 years at current production levels.

***Industrial Minerals.*—Diamond.**—CDM's capital expenditures and working cost for 1988 were estimated at $142.4 million, one-half of which flowed directly into the Namibian economy. CDM was responsible for about one-half of all direct taxes paid to the Government by the mining industry and 13% of all public revenue collected. Out of every 10 workers in the mining industry, 4 were employed by CDM earning about $35.4 million.

Average recovery grade continued to decline. CDM treated 16 million tons of ore, compared with 13 million in 1987. Ore grade was 5.8 carats per 100 tons, compared with 7.6 carats per 100 tons, respectively. Total overburden stripped was 42.8 million tons, compared with 32.2 million in 1987. This was attributed to a higher waste-to-ore ratio in the mining areas and the need to expose more ore for supplying the recommissioned No. 3 plant and the newly commissioned No. 4 plant's pretreatment facility. CDM's second bucket-wheel excavator was reactivated for meeting the higher waste and ore removal rates.

CDM had technical problems at the No. 1 plant in the recrushing of tailings and was unable to reach planned throughput. Although the pretreatment facility south of the No. 4 plant was commissioned, full production could not be achieved because higher than expected variations in the composition of feed material necessitated modifications, which were completed at year-end. CDM continued its trial dredging program for removal of overburden in the No. 4 plant area, and it completed construction of a floating screening plant to process dredged product. The process may afford successful processing of randomly distributed gravel lenses in the overburden, possibly leading to a larger scale operation.

In the No. 3 plant area, mining advanced 500 meters farther north. Despite heavy seas, the seawall was maintained 290 meters seaward of the high-water mark, with mining taking place at a depth of 5.5 meters below mean sea level. In the No. 2 plant area, mining covered over 700 meters of shore in two separate sections.

Positive results from prospecting supported the viability of another mining operation within Diamond Area No. 1 at Elizabeth Bay, about 30 kilometers south of Luderitz. Cost would be $60 million, and output would be 4 million tons per year of ore yielding 250,000 carats per year. Output would commence in 1991, and reserves were reported at 10 years at the planned production rate. Diamonds found at Elizabeth Bay are smaller than those found elsewhere in CDM's concessions, and final recovery from concentrates would take place at Oranjemund. The labor force was projected to be 350.

At Auchas, on the Orange River, CDM was proceeding with plans for a new $40 million mine, construction of which was to begin in 1989. Output at Auchas would be 1.2 million tons per year of ore following removal of 5.2 million tons per year of overburden. Yield would be 43,500 carats per year, with a recovery grade of about 3.6 carats per 100 tons, or about one-half CDM's average recovery for Namibia in 1987. Reserves were sufficient for 10 years of production at the projected rate, and output was to begin in late 1990. In addition to the Auchas site, nearby Arrisdrift and Daberas may also be opened.

CDM and MUN reached agreement on wages, overtime, shift and standby allowances, and annual leave. Wages in the lowest subgrade were to increase $44.35 per month, or 21.5%, and in the highest subgrade, $73.80 per month, or 20%. MUN originally sought a 35% increase in wages.

**Fluorspar.**—Okorusu Fluorspar (Pty.) Ltd. began crushing and milling of ore in September at the Okorusu Mine, north of Otjiwarongo. Production was estimated at 1,000 tons per week of fluorite, and reserves were about 3 million tons. The major shareholders were British, and Iscor, a minor shareholder, owned the concession. Capitalization for the project was $1.8 million, of which $800,000 was from the First National Development Corp. Exports were to Europe via Walvis Bay.

***Mineral Fuels.*—Natural Gas.**—Results by South West Africa Oil and Exploration Corp. (Pty.) Ltd. (Swakor) from the latest drilling program were said to be positive. A French offshore drilling rig completed a 4,526-meter test well, intersecting 90 meters of gas-bearing sandstone.

The company planned a $797,000 seismic survey in the Kudu area to be conducted in February and March 1989. About 800 kilometers of seismic data would supplement the 360 kilometers surveyed in 1985. Swakor was to establish a library for the storage and maintenance of all reports, studies, and research data on oil and gas, and determine which would be available for sale to interested parties.

A joint venture involving United States and Taiwan interests was formed to investigate the onshore oil potential of an area near Etosha Pan.

**Uranium.**—RTZ Corp. fully regained its $164.3 million startup costs for the Rossing Mine, and with state-of-the-art processing technology has remained profitable despite nonrenewal of expiring long-term contracts. All uranium output was delivered under long-term contracts, which carried a higher price than either current contracts or spot market prices. Output was reported at 80% of capacity. Owing to the Comprehensive Anti-Apartheid Act of 1986, which embargoed uranium imports from the Republic of South Africa-Namibia, sales could not be made directly to the

United States. Exports were in 400-kilogram steel drums via Walvis Bay and were primarily to the United Kingdom and Europe. The labor force was about 2,000, and average take-home salary was about $657 per month. Rent, water, and electricity costs to the workers were nearly 100% subsidized by the company. The Rossing Mine provided about 35% of Namibia's export earnings and 17% of the GNP.

A $531,000 order was placed with Siemens Ltd. for extensions to the direct current electric overhead trolley system. The alternative power supply for Rossing Mine's 170-ton haul trucks will reduce fuel consumption from 24 liters per kilometer to less than 4 liters per kilometer and will allow twice the normal operating speed. About 50% of the equipment would be supplied from the Republic of South Africa and the remainder from the Federal Republic of Germany.

## SWAZILAND[12]

Mining was a small but important factor in Swaziland's economy, accounting for about 4% of the country's GDP which was dominated by agriculture, particularly the production of sugar, citrus fruit, and wood pulp. Overall mining revenues decreased 0.3% to $19.12 million[13] in 1988, although in local currency terms the revenues increased by 12%. Asbestos continued to be the largest mining revenue earner, followed by diamonds, coal, and crushed stone. Swaziland's workforce included an estimated 92,000 wage earners, of whom about 2,100 worked in mines in Swaziland. In addition, about 17,000 Swazis worked in mines in the Republic of South Africa. It was estimated that about 13% of Swaziland's population was directly supported by mine wages, which totaled approximately $45 million in 1987.

About 90% of Swaziland's imports originated in or passed through the Republic of South Africa. In 1987, imports were $431.5 million, of which mineral fuels and lubricants, for which the country was entirely import-dependent, comprised almost $65 million. Swaziland's exports totaled almost $400 million. About 40% of the country's exports went to the Republic of South Africa. Trade with the United States was minor, consisting of about $19 million in exports to the United States and only about $4 million in imports. None of the trade with the United States was in mineral commodities.

Minerals in Swaziland were vested in the King, in trust for the Swazi nation. Mining matters were overseen by a Minerals Committee, which was completely restaffed in late 1987. At that time, a Minerals Negotiations Committee was formed to renegotiate certain existing mining leases. Higher royalty agreements were negotiated in late 1988 with Emaswati Coal (Pty.) Ltd. and with the operators of the Dvokolwako[14] Mine. The new agreement with the coal company provided for a production-related royalty of between 3% and 5%. The company was to pay 12.5% of gross revenues, instead of the 7% of net revenues paid previously. In both cases, the new royalties were to be applied retroactively to the commencement of mining.

Most mining ventures had state participation through Tibiyo Taka Ngwane (TTN), formed in 1968. Through its investments, this organization became self-supporting in 1976 and since that time, mine royalties have been diverted to another parastatal, Tisuka Taka Ngwane, for the support of housing and infrastructure development.

Asbestos was produced solely by the Havelock Asbestos Mine in the Makhonja Mountains in the northwest part of the country. The mine was operated by Turner & Newall Group PLC of the United Kingdom, in joint ownership with the Government. Production had suffered in recent years because of declining grades, increasingly difficult ground, and low world asbestos prices, which were partly related to health concerns. In addition, reserves were expected to be exhausted by 1990. Additional reserves had been outlined nearby in what was known as the Far West Area, but permission to mine there had been delayed by the Government, pending review of certain management, health, and environmental issues.

Asbestos fiber production declined 12% to about 23,000 tons, and revenues declined 16.4% to about $8.5 million. Total ore milled declined almost 18% to 600,500 tons. The grade, however, was slightly higher at 3.86% fiber.

Total asbestos sales in 1988 declined 19% to 22,820 tons, of which 22,570 tons were exports. Of these exports, 9,900 tons were to the Republic of South Africa, 3,870 tons were to Thailand, 3,100 tons were to France, and 2,740 tons were to Japan. All exports were through Barberton in the Republic of South Africa.

A revised mining plan was introduced in February, under which the staff at the Havelock Mine was reduced from 1,876 to 1,484 workers, and the production rate was cut 20% to 50,000 tons per month of ore. However, in February, the Government guaranteed a $4.4 million loan from Barclays Bank to the mine to keep the company solvent until operations could be transferred to the Far West Area. In April, an exclusive prospecting license was granted to the company for the Far West Area, and this was converted to a mining lease in December. Asbestos production from the new area was scheduled to start in early 1989, with full production expected by mid-1990.

Coal (anthracite) was produced at Mpaka by Emaswati Coal (Pty.) Ltd., which was managed by Trans-Natal Coal Corp., a subsidiary of General Mining Union Corp. of the Republic of South Africa. Coal production decreased slightly to 164,845 tons. Mine revenues decreased 4.6% to $3.1 million. Total sales increased 2.4% to 191,570 tons. Export sales increased

2% to 160,240 tons. Export revenues were $2.51 million, down slightly in dollar terms from 1987 of $2.6 million, but up 7.5% in terms of local currency. As in years past, the largest purchaser of Mpaka coal was the Bamburi Cement Works in Kenya, which took 130,690 tons in 1988. The Republic of Korea took 29,550 tons. Domestic sales were largely to various sugar estates. Coal exports were transported by rail largely to the port of Maputo in Mozambique. Transport by this route suffered from attacks in Mozambique by guerrilla forces, especially in the first half of the year and in November. At such times, coal shipments were rerouted to the export facilities at Richards Bay, Republic of South Africa. In 1988, some production at Mpaka was from a new production area to the south of the old workings. Modifications to some of the old underground workings were underway during the year. The processing facilities were planned to be upgraded during 1989. The coal mine employed 352 workers.

Diamonds were produced at the Dvokolwako Mine, operated and owned 50% by Trans Hex, a subsidiary of the Rembrandt Group, Republic of South Africa. The remaining 50% was owned by the Swazi nation. Reported production in 1988 was almost 73,000 carats, an apparent decrease from estimated 1987 production levels, but well in excess of earlier production. Mine revenues were $6.52 million, well above the 1987 revenues of $4.94 million and the 1986 revenues of approximately $2 million. Diamond sales were held in Europe, independent of De Beers' CSO, and overlapped the production years. The diamonds were described as being mostly industrials, but with some low-quality and a few high-quality gems. Sales and ex-mine revenues suggest that the Dvokolwako diamonds were fetching on average in excess of $70 per carat.

The Dvokolwako Mine was an open pit operation exploiting weathered kimberlite having a surface extent of almost 3 hectares. The deposit had been drill-proved to a depth of 80 meters, and the company was planning to test the deposit to a depth of at least 250 meters. The company expected to extend the open pit to 60 to 80 meters depth, and then to mine underground in fresh kimberlite below that depth. In 1988, the mine employed 149 workers.

There were two commercial stone quarries in operation throughout the year. Another quarry, near Lavumisa, was reopened during the first quarter to supply road metal for a local road-tarring project.

Total stone production increased 11.5% to 107,205 cubic meters. Revenues increased almost 21% to slightly more than $1 million. This increase was largely owing to a 34% increase, 91,025 cubic meters, which in turn reflected an increase in construction in the country from April.

Australian Overseas Mining Ltd. (AOM) announced that the Government had approved a high-carbon ferrochrome plant having an annual production capacity of 120,000 tons of ferrochrome. The plant was to use kiln reduction technology developed by Krupp Industrie of the Federal Republic of Germany to produce a 55% chromium ferrochrome product. The plant would use about 1,150 kilowatts electricity per ton of product, which was to be supplied through the Swaziland grid, but which would necessitate additional purchases of electricity from the Republic of South Africa. Negotiations between the Government and the Republic of South Africa over the price of this electricity were ongoing late in the year. The remainder of the plant's energy requirements were to be met with anthracite from the Mpaka Mine. The chromite was to be imported from the Dilikong Mine in Lebowa, Republic of South Africa.

The project was originally a joint venture among Australian companies AOM, 35%; German Mines Ltd., 20%; and Boulder Gold, through its subsidiary Chrome Corp. Interna-

TABLE 12

**SWAZILAND: PRODUCTION OF MINERAL COMMODITIES[1]**

(Metric tons unless otherwise specified)

| Commodity[2] | | 1984 | 1985 | 1986 | 1987[p] | 1988[e] |
|---|---|---|---|---|---|---|
| Asbestos, chrysotile | | 25,832 | 25,130 | 20,908 | 25,925 | [3]22,804 |
| Coal, anthracite | | 124,569 | 166,179 | 172,145 | 165,371 | [3]164,845 |
| Diamond | carats | 16,837 | 21,128 | 39,144 | [r e]80,00 | [3]72,676 |
| Stone: Quarry product | cubic meters | 97,657 | 83,903 | 120,723 | 96,114 | [3]107,205 |
| Tin, mine output, Sn content | | 1 | — | — | — | — |

[e] Estimated [p] Preliminary [r] Revised

[1] Includes data available through Feb. 20, 1990.

[2] In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, sand and gravel, and stone) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

[3] Reported figure.

tional, 10%; Luxembourg companies International Metals S.A. and Luxembourg Alloys Co., 10% each; and the Swazi nation, 15%. Later in the year, TTN acquired the shares of Luxembourg Alloys and half the shares of International Metals. Toward yearend, the joint venture was seeking an operating partner. There was some doubt as to the economics of the project, especially given planned ferrochrome capacity increases at plants elsewhere in the world, most notably in the Republic of South Africa.

Swaziland was an important gold producer earlier in the century. While several companies were continuing to explore for gold in the Piggs Peak and Nhlangano areas, there was no commercial gold production in 1988. Swaziland's recoverable coal reserves were estimated to be in excess of 1 billion tons, and it was considered quite likely that a second coal mine would be established by the mid-1990's. Swaziland had significant resources of various industrial minerals and the Government was actively seeking foreign firms to test some of the deposits. The country had once had minor tin production, but the potential for developing new tin mining was considered minimal in light of low world tin prices. Swaziland had significant resources of low-grade iron mineralization, primarily near the old Ngwenya Iron Mine, which closed in 1977.

Tenders were sent to various French firms to study the feasibility of constructing a hydroelectric dam on the Komati River. The French Government and the World Bank were to finance the construction project, which was expected to cost at least $43 million. In order to reduce the country's dependence on imported fuel, the Government was strongly supporting a project to establish an ethanol production plant in Mhlume in the northern part of the country. The plant was to utilize the abundant molasses produced by the sugar plantations. Project Engineering Africa, of the Republic of South Africa, was conducting the feasibility study of the estimated $8.3 million project, which was envisioned as producing about 63,000 barrels of ethanol per year by 1990. A feasibility study completed in 1987 recommended that plans be dropped for the construction of a second, smaller plant in the eastern part of the country.

## ZAMBIA[15]

Zambia's economy hinged on its mineral industry in 1988 as in previous years. The minerals sector provided about 15% of the GDP and about 90% of export earnings. Refined copper alone, of which Zambia continued to be among the top one-half dozen world producers, earned over $1 billion[16] or about 85% of export earnings. A strategic coproduct, cobalt, was also important. Zambia was outranked in world output only by Zaire and cobalt sales generated about $70 million. Precious and semiprecious gem stones, especially emeralds, and zinc were also significant in the world market. Cement, coal, lime, and nitrogen were important products locally. In addition to other mineral production, the potential for adding nickel and iron was being investigated.

Although the economy depended heavily on the mineral industry, reports indicated that the sector directly employed only 62,000 workers, compared with an estimated 350,000 formally employed in industry, commerce, and Government. Some estimates indicate that five or more other jobs were dependent on each worker employed in the mining sector. Furthermore, many small-scale miners undoubtedly escaped counting. About 2.5 million citizens were said to be economically active, and about 85% of these were in agriculture. Total population, having grown about 3.6% during the year, was about 7.75 million at yearend.

Training of personnel to upgrade skills continued to be a recognized need for the mineral industry, particularly by Zambia Consolidated Copper Mines Ltd. (ZCCM), which employed more than 85% of the mineral-sector workers, including 1,371 expatriates. In-house programs were used to train many employees at ZCCM, plus some 300 awards for study either locally or abroad.

In the work force area, ZCCM, through the Copper Mining Enterprises Trust (COMET) it established, reportedly allotted the equivalent of about $1 million to reopen the Kansanshi copper mine, about 250 kilometers west of Kitwe. Otherwise unneeded miners would be kept at work while training unemployed youths. COMET had operating workshops and a small zinc mine in the Kabwe Div.

In general, Zambia continued to face serious economic difficulties despite record-high copper prices and a bumper corn crop in 1988. These two positive developments only partially offset damage done by years of low copper prices, falling copper production, drought, high birth rate, and management problems in Government and parastatal firms. The latter companies dominated the industrial scene, accounting for more than 60% of GDP. The resulting conditions contributed to rising unemployment, severe constraints on imports, and growing foreign debt. The chronic shortage of foreign exchange restricted industrial growth, industrial diversification, and maintenance programs.

Among the economic reforms announced early in 1988, the Government scrapped the mineral export tax. It also granted ZCCM permission to retain up to 40% of its export earnings.

In November the Government devalued the kwacha from 8 to 10 per U.S. dollar, thus boosting export revenues, and, at yearend, appeared to be considering some kind of rapprochement with the IMF.

Zambia's GDP, according to data published by the IMF, was equivalent

to $2,737 million in 1988, based on the annual average exchange rate. This was 24% higher than in 1987, even though on a kwacha basis it was only 15% higher. But in constant dollars the real growth was elsewhere reported to be only 2.7%. Consumer prices increased more than 55% during the year according to the IMF data.

The United Nations Revolving Fund for Mineral Exploration promised to help Zambia in setting up a trust bank presumably with emphasis on promoting small-scale mining. Donors were being sought. The World Bank was also reported to be involved.

The Ministry of Mines announced reexamination of all licenses of small-scale miners of gem stones because of evidence of failure to declare their production. This was in line with a campaign to cut the widespread smuggling and black-market operations, which were given prominent notice in several Government releases. Preventing any further theft of copper from rail shipments was also given attention by the Government.

Transportation problems, especially railcar and locomotive shortages on the Tanzania-Zambia Railway Authority (Tazara) railroad connecting the Copperbelt, Lusaka, and Dar es Salaam in Tanzania. Problems on the rail and road-rail routes between Lusaka and Beira in Mozambique also continued to be reported.

Austria, Australia, China, the Federal Republic of Germany, and the United Kingdom, as well as international organizations, pledged assistance to Tazara's 10-year development plan. The plan gave priority to telecommunications, locomotives, and railcars. Tazara raised rates 10% in July partly to finance the plan.

Road repair also received funding from the African Development Bank and bilateral donors as did the crude oil pipeline from Dar es Salaam to Zambia's Copperbelt refinery at Ndola. Pipeline rehabilitation began in July. Work on the 1,710-kilometer Tazama pipeline was being done by Snamprogetti S.p.A. of Italy and was being financed by an Italian Government loan. Repair of leaks was a major component of the project.

**Production and Trade**

The value of mineral production was higher in 1988 than in 1987. However, although revenues from copper, the key mineral commodity, increased due to higher market prices and reduction of the mineral export tax, the quantity produced declined. The chronic decline was due to a lack of spare parts, mismanagement, and transportation problems. Additionally, equipment and work force skills have deteriorated.

Cobalt and zinc production was up slightly as was gem stone production. Much of the emerald production was reported to be marketed through illegal channels, and the Government was making efforts to gain effective control of marketing.

The value of exports increased 31% in 1988 to the equivalent of $1,190 billion according to IMF data. Apparently due to the dominance of copper, Japan was the major destination by far for exports based on value. Other leading exports, ranked in order of value, were zinc, cobalt, lead, and tobacco. Zinc and cobalt were the two principal U.S. imports from Zambia. In recent years France, India, and Italy were consistently large buyers of copper; and smaller purchases were made by Greece and Thailand. All exports were hampered by transportation difficulties especially on the Tazara railroad to Dar es Salaam, which in 1986–88 was estimated to have been the route for 75% to 85% of the copper. The balance of copper went primarily through Beira in 1988. During 1988, the Ministry of Mines announced that copper shipments through the Republic of South Africa, a major route in earlier years, had ceased completely in March 1987.

Imports were equivalent to $834 million according to IMF data, essentially the same as in 1987 on a dollar basis. Principal items were machinery, electricity, mineral fuels, manufactures, and chemicals. Sources were mainly the Republic of South Africa, the United Kingdom, and Saudi Arabia (for crude oil). Crude petroleum was by far the major mineral import, and iron and steel and fertilizer were of less importance. Mining equipment was the major import from the United States. However, the shortage of foreign exchange severely limited the importation of items crucial to maintaining, much less increasing, industrial production.

**Commodity Review**

***Metals.*—Cobalt.**—Cobalt production increased only slightly in the year ending March 31, 1989 (fiscal year 1988), according to late reports of ZCCM. In January, ZCCM, jointly with Gecamines in Zaire, announced a $0.50 per pound increase to $7.50 for the so-called producer price of cobalt. In November, the two producers also proposed a quality grading program and asked consumers to make suggestions.

Memaco Trading Ltd., sales agents for ZCCM's cobalt, started up a U.S. subsidiary in April with offices near Cleveland, Ohio, and a warehouse in New Jersey.

**Copper.**—ZCCM's output of refined copper dropped more than 10% in fiscal year 1988, ending March 31, 1989, but revenue increased and profits soared 500% due to higher prices, lower taxes, and the devalued kwacha. Late 1988 delays in export shipments prevented profits from being higher. The company repeated claims that continued production declines were due to a variety of operating problems. One problem was that open pit ore production was lost due to the need to complete overburden stripping. Other problems were: loss of expatriates resulting from the Zambianization program; lower equipment availability due to poor maintenance caused by lack of trained personnel and spare parts, the latter the result of inadequate alloca-

TABLE 13

## ZAMBIA: PRODUCTION OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

| Commodity | | 1984 | 1985 | 1986 | 1987[p] | 1988[p] |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Beryllium: Beryl | kilograms | e100 | 482 | 723 | 1,131 | 1,343 |
| Cobalt:[2] | | | | | | |
| Mine output: | | | | | | |
| Ore milled, gross weight | thousand tons | 6,938 | 6,681 | 6,864 | 7,015 | e7,000 |
| Co content | do. | 8,652 | 10,445 | 8,656 | 11,198 | e11,000 |
| Concentrate: | | | | | | |
| Gross weight | do. | 197,912 | 244,531 | 294,569 | 295,285 | e295,000 |
| Co content | do. | 4,344 | 6,674 | 5,682 | 7,315 | e7,000 |
| Metal: | | | | | | |
| Materials treated, gross weight | do. | 261,226 | 230,649 | 281,189 | 286,024 | e285,000 |
| Co content | do. | 6,049 | 6,459 | 5,743 | 7,261 | e7,000 |
| Refined electrolytic cathode | do. | 3,654 | 4,565 | 4,160 | 4,694 | 4,871 |
| Copper:[2] | | | | | | |
| Mine output: | | | | | | |
| Ore milled, gross weight | thousand tons | 28,721 | 25,372 | 26,010 | 24,419 | r23,517 |
| Cu content | do. | 633,203 | 553,161 | 537,261 | 507,446 | r632,607 |
| Concentrate: | | | | | | |
| Gross weight[4] | do. | 1,938,414 | 1,624,252 | 1,682,355 | 1,642,907 | e1,500,000 |
| Cu content[4] | do. | 510,840 | 429,450 | 423,397 | 403,450 | e375,000 |
| Electrowon cathode from tailings leachate | do. | 75,128 | 63,182 | 90,598 | 98,306 | e100,000 |
| Metal: | | | | | | |
| Smelter: | | | | | | |
| Blister anodes[5] | do. | 416,734 | 386,963 | 349,469 | 347,904 | e315,000 |
| Electrowon cathodes from copper ore tailings and concentrate leachate | do. | 105,861 | 31,877 | 113,252 | 117,246 | e110,000 |
| Electrowon cathodes from cobalt ore concentrate leachate | do. | 20,048 | 22,033 | 26,556 | 27,228 | e30,000 |
| **Total** | do. | **542,643** | **490,873** | **489,277** | **492,383** | **e455,000** |
| Refined: | | | | | | |
| Electro refined[6] | do. | 397,861 | 383,450 | 352,150 | 347,342 | 311,983 |
| Shapes[7] | do. | 93,753 | 79,872 | 94,376 | 79,281 | 85,728 |
| Electrowon[8] | do. | 38,696 | 33,193 | 51,068 | 69,638 | 51,848 |
| **Total** | do. | **530,310** | **496,515** | **497,594** | **496,261** | **449,559** |
| Gold[9] | troy ounces | 12,185 | 7,909 | 1,865 | 11,253 | 8,423 |
| Iron ore: Magnetite | | 595 | 984 | 637 | 910 | 445 |
| Lead: | | | | | | |
| Mine output, Pb content of ore | | 18,124 | 15,021 | 14,851 | 14,516 | 11,782 |
| Metal, refined[10] | | 8,825 | 8,873 | 6,648 | 7,979 | 6,385 |
| Manganese concentrate (77% Mn), gross weight | | 250 | 1,870 | 554 | — | 502 |
| Selenium: | | | | | | |
| Refinery muds, Se content[e] | kilograms | 33,650 | 37,790 | 29,870 | 42,650 | 40,000 |
| Metal, refined[10] | do. | 19,490 | 15,405 | 22,150 | 26,819 | r24,350 |
| Silver[9] | thousand troy ounces | 795 | 607 | 861 | 961 | 943 |
| Tin concentrate, gross weight | | 4 | 22 | 3 | 24 | 2 |
| Zinc: | | | | | | |
| Mine output, Zn content of ore | | 41,128 | 31,956 | 33,017 | 35,443 | 33,895 |
| Metal, smelter and refined | | 29,177 | 22,766 | 22,493 | 21,025 | 20,220 |

See footnotes at end of table

TABLE 13—Continued

## ZAMBIA: PRODUCTION OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

| Commodity | | 1984 | 1985 | 1986 | 1987[p] | 1988[p] |
|---|---|---|---|---|---|---|
| INDUSTRIAL MINERALS | | | | | | |
| Cement, hydraulic | thousand tons | 241 | 316 | 334 | 375 | 405 |
| Clay: Brick | | 12,010 | 2,612 | 4,627 | 6,606 | [e]5,000 |
| Building, not further specified | | 209 | 2,290 | 4,627 | 3,096 | 1,000 |
| China | | 331 | 642 | 515 | 315 | 367 |
| Feldspar | | 184 | 185 | 214 | 45 | 120 |
| Gem stones: | | | | | | |
| Amethyst | kilograms | 24,827 | 19,612 | 6,991 | 3,757 | 4,701 |
| Aquamarine | do. | 1 | 3 | ([11]) | 63 | 56 |
| Emerald | do. | 23 | 115 | 413 | 992 | 1,039 |
| Lime, hydraulic and quicklime | thousand tons | 232 | 256 | 243 | 235 | 239 |
| Nitrogen: N content of ammonia | | 27,900 | 17,600 | [r]24,700 | [r]33,330 | 16,200 |
| Pyrite concentrate, gross weight | | 18,172 | 28,288 | 19,187 | 45,447 | 67,487 |
| Sand and gravel, construction | thousand tons | 78 | 61 | 129 | [e]75 | [e]75 |
| Stone: | | | | | | |
| Limestone | do. | 916 | 702 | 705 | 720 | 999 |
| Phyllite | do. | 17 | 13 | 19 | 22 | 25 |
| Miscellaneous (building) | do. | 73 | 108 | 134 | 130 | 1,536 |
| Sulfur, byproduct:[e] | | | | | | |
| S content of pyrite concentrate | | 7,800 | 11,900 | 8,000 | 19,400 | 27,300 |
| S content of sulfuric acid from smelter gas | | 79,000 | 79,000 | 74,000 | 74,000 | 74,000 |
| **Total** | | **86,800** | **90,900** | **82,000** | **93,400** | **101,300** |
| Talc | | 367 | [e]1,900 | 266 | 258 | 73 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Coal, bituminous | thousand tons | 510 | 471 | 557 | 463 | 524 |
| Petroleum, refinery products:[2] | | | | | | |
| Liquified petroleum gas | thousand 42-gallon barrels | [r]72 | [r]75 | 60 | 77 | 84 |
| Gasoline | do. | [r]1,020 | [r]873 | 916 | 972 | 1,149 |
| Jet fuel | do. | [r]347 | [r]291 | 361 | 416 | 520 |
| Kerosene | do. | [r]216 | [r]198 | 239 | 253 | 318 |
| Distillate fuel oil | do. | [r]1,706 | [r]1,604 | 2,078 | 2,041 | 2,149 |
| Residual fuel oil | do. | [r]761 | [r]670 | 624 | 615 | 564 |
| Other, including refinery fuel and losses | do. | [r]374 | [r]362 | 418 | 407 | 466 |
| **Total** | **do.** | **[r]4,496** | **[r]4,073** | **4,696** | **[r]4,781** | **5,250** |

[e] Estimated. [p] Preliminary. [r] Revised.

[1] Table includes data available through Sept. 1, 1989.

[2] Data are for year beginning Apr. 1 of that stated.

[3] Data are for calendar year ending Dec. 31 of year stated.

[4] Includes cobalt concentrates as shown under cobalt entry above, all of which contain some copper that is recovered.

[5] Includes following quantity of blister anodes produced on toll from Zairean concentrates in metric tons: 1984–9,964; 1985–32,300; 1986–26,897; 1987–29,077; 1988–[e]26,000.

[6] Includes the following quantity of electrolytic refined cathodes produced on toll from Zairean concentrates processed into blister copper in metric tons: 1984–4,499; 1985–33,161; 1986–26,111; 1987–28,099; 1988–[e]25,000.

[7] Reported as "finished production, shapes" (wirebar and billets), presumably produced from furnace-refined lower grade electrowon cathodes and/or high-grade electrowon cathodes and some furnace-refined blister anodes.

[8] Reported as "finished production, leach cathodes," presumably sufficiently high-grade electrowon cathodes that required no further refining. In 1986 and 1987, apparently also included electrowon cathodes not further refined but not necessarily high-grade, produced on toll by one company for another, amounting to 501 tons in 1986 and 106 tons in 1987.

[9] Mostly from refinery muds.

[10] For practical purposes, Zambian outputs of crude and refined lead metal are regarded as equal.

[11] Less than 1/2 unit.

tion of foreign exchange; supply shortages due to transportation bottlenecks; low worker productivity and poor supervision; and, early in 1988, a shortage of sulfuric acid. No major improvements were expected for the immediate future, although about $9 million was set aside for training replacements for expatriates.

Ndana smelter was reportedly being overhauled early in 1988 and technology from Chile was to be introduced, according to ZCCM officials.

Plans to reopen the Kankola Shaft No. 3 were announced by ZCCM, and Chinese Trust & Investment Corp. officials were reportedly discussing with ZCCM the possible reopening of the Chambishi Mine, which was closed in 1986, as part of ZCCM's 5-year plan for reconstruction of the industry.

Reports of extensive fire damage to a sulfuric acid plant at ZCCM's Nkana Div. in September were quickly disclaimed by the company. Only small damage to an outlet duct without loss of production occurred.

ARA Inc., a Tamrock subsidiary, was awarded a 4-year contract to supply about 40 load-haul-dump vehicles and services to ZCCM. Reportedly worth $75 million, it was claimed to be one of the largest supply contracts ever given to an underground loader equipment company. The contract was expected to reduce the parts supply problems in addition to other benefits.

Interests in reopening the Mkushi copper mine and concentrator south of the Copperbelt was being promoted by a Zambian company late in the year. The operation was closed in 1975 by its Italian owner.

**Gold.**—Prospecting by French, British, and Italian companies was announced by the Minister of Mines late in 1988. ZCCM also was active, particularly at Matala, a former producer, 130 kilometers west of Lusaka, where resources of 30,000 ounces of fine gold were reported.

At yearend, ZCCM's Small Mines Development Unit was reportedly planning to reopen the Dunrobin operation in the same locality. Old tailings estimated to contain 58 kilograms of gold in 68,600 tons of tailings, would be processed in about 2 years using shovels, wheelbarrows, and cyanide leach tanks. The mine, operated from 1928 to 1932 until water inflow caused its closing, was also being considered for reopening. Twenty other deposits that were worked before World War II were also being considered for reopening. They are located in Mumbwa District, Central Province. Another 83 occurrences to be examined reportedly stretch 600 kilometers to the Petauke District in Eastern Province.

**Iron and Steel.**—Based on results of a feasibility study, the U.S.S.R. and Zambia were reported to have signed an agreement in December on establishing an iron and steel plant in Zambia. Agreement details were not announced, but such a plant was one of the major projects in Zambia's Fourth National Development Plan ending in 1993. It was to be based on local high-grade iron ore (containing up to 60% iron), coal, and limestone using a rotary-kiln direct-reduction process. Contracts for construction were expected to be signed by yearend 1989. During 1989, engineers from the U.S.S.R. were to further investigate the project's first phase, which was to provide a 100,000-ton-per-year steel capacity within 5 years.

**Lead and Zinc.**—Production of lead and zinc was reported to have been lower in fiscal year 1988 in line with recent trends caused by depletion of ore and the mining of lower grades.

The Finnish Development Agency and Outokumpu of Finland were considering support to a lead-zinc project in the Kabwe area, 75 kilometers north of Lusaka.

**Nickel.**—The Munali nickel deposit was being restudied by Apollo Mining Ltd. of Zambia, owner of the license for the site. The site was about 65 kilometers south of Lusaka and was outlined with 68 drill holes, some completed to depths of 800 meters.

***Industrial Minerals.*—Gem Stones.**—A new company, Kariba Minerals Ltd., was announced as a joint venture between Lonrho PLC and the Zambian Government to mine amethyst at Mapatizya in the Zambezi Valley. According to the report, the deposits had been worked in the 1960's and early 1970's.

**Nitrogen.**—A contract for revamping ammonia and other facilities of Nitrogen Chemicals of Zambia at Kafue was reported in March.

**Sulfur.**—Iron pyrite production of 28,843 tons hoisted broke the record in June at the Nampundwe Mine near Lusaka. The nominal 40% sulfur concentrates were trucked to acid plants on the Copperbelt to make acid for use in ZCCM's tailings leach plants.

***Mineral Fuels.*—Coal.**—Maamba Collieries of Zambia produced 500,000 tons of coal in 1988 and in fiscal year 1988, ending March 31, 1989, made more than $3.5 million profit, more than 11 times the previous year's profit. The company credits the improvement to the continuing rehabilitation program at the mine.

***Petroleum.***—Exploration.—According to Zambian news agencies, Placid Oil Co. of the United States, which had been prospecting in Western Province, had ceased operation and returned some equipment to the United States. Reason for the action was not known.

***Pipeline.***—European Investment Bank was reportedly planning to lend $16 million for rehabilitation of the Dar es Salaam to Ndola pipeline.

## ZIMBABWE[17]

In 1988, the volume of crude mineral production declined slightly, but the value increased 20% in Zimbabwean dollars and 12% in U.S. dollars to $547 million.[18] Higher commodity prices worldwide were primarily responsible for the increase. Gold again had the highest value in terms of crude mineral production at $380 million. Nickel had the highest increase in value of any commodity. In terms of export value, ferrochromium was the highest foreign-exchange earner for the mineral industry at $399 million.

Revised data for the real GDP indicate that since independence in 1980 the economy has grown at an average rate of 3% per year, slightly above the rate of population growth. A minimum of about 5.5% real growth was necessary to absorb new employees and provide a reasonable increase in per-capita income. GDP in 1988 was $5.6 billion, and the actual growth was 4.9%. The budget deficit for 1988–89 was estimated at about $600 million and resulted primarily from spending on defense, education, and subsidies to parastatal corporations. Subsidies to the latter totaled $330 million and included the Zimbabwe Iron and Steel Co. (Zisco) and the National Railways of Zimbabwe (NRZ). The inflation rate was estimated at 15%, exacerbating the mining industry's shortage of foreign exchange, and was forecast to deteriorate further.

The mining industry was hampered by a severe shortage of foreign exchange. The Chamber of Mines requested $98 million in foreign exchange for the industry but received less than 50% of that asked. The inability to secure spare parts and equipment caused loss of production in some mines, and lost development and even exploration drilling at others. An estimated $28 million of exportable output was reportedly lost because of a foreign-exchange shortage.

The budget of the Ministry of Mines was $29 million. Allocation of a portion of this funding to cover losses by the Zimbabwe Mining Development Corp. (ZMDC) resulted in inadequate funding for mine inspections.

The Chamber of Mines reported severe shortages of metallurgists and geologists in the industry's skilled labor force. Total skilled labor was 2,224 workers and 180 vacancies were reported, primarily owing to new mine developments.

The Intermediate Technology Development Group, in conjunction with the British Geological Survey, planned to set up a custom milling and mining center in the Shamva area for small-scale mining operations. The objective was to improve the safety and efficiency of the increasing number of artisanal miners in the gold-mining districts. The ultimate goal was to establish profitable operations.

The death rate per 1,000 workers employed in the mining industry in 1987, the latest available, was 0.60 based on 35 deaths within a labor force of 58,464.

### Government Policies and Programs

The Mines and Minerals Act, reflecting the new mining law of Zimbabwe, stated that a prospector must be a citizen of Zimbabwe, or employ a local agent. Prospecting was no longer permitted within 500 meters of any dwelling or on land actively being farmed. Unused farm land could be staked. A license, which required payment of a fee, and an examination were required of prospectors. Coal and uranium, which were considered strategic materials, required a special grant. For prospecting in areas of more than 100,000 hectares, an Exclusive Prospecting Order was required from the Mining Affairs Board. For mining permission, mining rights had a legal advantage over land rights.

The ZMDC undertook exploration for gold, copper, and industrial minerals. Activity centered on determining the economic viability of the Sanyati polymetallic deposit, which contained copper, lead, and zinc, as well as recoverable sulfur. ZMDC reported that 44 registered mining cooperatives joined during the year.

### Production and Trade

Total mineral export earnings in 1988 were $753.3 million, compared with total exports of $1,595 million. Gold sales were $211.7 million. Total imports were $1,145 million. U.S. exports to Zimbabwe were $34.3 million and consisted primarily of aircraft, computers, equipment, and synthetic fiber. U.S. imports from Zimbabwe were $126.7 million and consisted primarily of ferrochromium, nickel, coffee, and sugar.

The Republic of South Africa was Zimbabwe's largest trading partner. About 60% of Zimbabwe's trade transits South Africa, down from 90% over the past 5-year period. Mineral sales, excluding gold, remained under the control of the Minerals Marketing Corp.

The NRZ indicated that it had sufficient supplies of railroad cars but a shortage of diesel locomotives. About 50% of the country's 250 locomotives were out of service owing to a shortage of spare parts.

### Commodity Review

*Metals.*—**Chromite.**—Zimbabwe remained a major world producer of chromite, both from podiform and stratiform deposits. Output was all consumed domestically in the production of ferrochrome. The chief Government mining engineer reported that the long-term future of the chromite mining industry was dependent upon cooperatives. The concept had been developed previously, but it was not implemented. Most output was from two mines owned by Zimbabwe Mining and Smelting Co. (ZIMASCO) and Zimbabwe Alloys Ltd. (Zimalloys).

**Copper.**—Corsyn Consolidated Ltd.,

TABLE 14

## ZIMBABWE: PRODUCTION OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

| Commodity | | 1984 | 1985 | 1986 | 1987[p] | 1988[e] |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Aluminum: Bauxite, gross weight | | 22,726 | 20,877 | 24,284 | — | — |
| Antimony, mine output, concentrate, Sb content | | 256 | 194 | 175 | 153 | 150 |
| Beryllium: Beryl concentrate, gross weight | | 19 | 38 | 103 | 83 | 80 |
| Chromium: Chromite, gross weight | | 476,521 | 536,490 | 533,105 | 570,000 | 600,000 |
| Cobalt:[2] | | | | | | |
| Mine output, Co content[e] | | 78 | 100 | 76 | 110 | 126 |
| Metal | | 78 | 92 | 76 | 110 | [3]126 |
| Columbium and tantalum: Tantalite concentrate: | | | | | | |
| Gross weight | kilograms | 59,000 | 40,000 | 33,000 | 37,000 | [3]66,000 |
| Cb content[e] | do. | 8,850 | 6,000 | [r]5,000 | [r]2,600 | 9,900 |
| Ta content[e] | do. | 20,650 | 14,000 | [r]11,600 | [r]6,100 | 23,100 |
| Copper: | | | | | | |
| Mine output, concentrate, Cu content[e] | | 24,000 | 21,570 | 21,390 | [r]19,800 | 16,900 |
| Metal: | | | | | | |
| Smelter output, blister/anode, primary[e 4] | | 23,000 | 20,670 | 20,500 | 19,000 | 16,116 |
| Refinery output, refined/cathode, primary | | 22,687 | 20,389 | 20,423 | 18,819 | [3]16,116 |
| Gold | troy ounces | 478,307 | 472,327 | 477,535 | 472,937 | 475,000 |
| Iron and steel: | | | | | | |
| Mine output, iron ore: | | | | | | |
| Gross weight | thousand tons | 927 | 1,100 | 1,110 | 1,328 | 1,020 |
| Fe content[e] | do. | 555 | 660 | 670 | 824 | 632 |
| Metal: | | | | | | |
| Pig iron[e] | do. | 400 | 674 | 644 | [r]575 | 600 |
| Steel, crude | do. | 391 | [e]465 | 490 | 515 | 500 |
| Ferroalloys: | | | | | | |
| Ferrochromium | | 177,800 | 156,000 | 155,000 | 212,300 | 180,000 |
| Ferrochromium-silicon | | 42,482 | 53,527 | 50,000 | 21,192 | 40,000 |
| Ferromanganese | | 1,845 | 2,044 | 2,000 | — | 2,000 |
| **Total** | | **222,127** | **211,571** | **207,000** | **233,492** | **222,000** |
| Nickel: | | | | | | |
| Mine output, concentrate, Ni content[e] | | 12,150 | 11,116 | 10,370 | 12,320 | 12,000 |
| Refinery output, refined metal[5] | | 10,251 | 9,381 | 9,730 | 10,394 | 10,000 |
| Platinum-group metals: | | | | | | |
| Palladium | troy ounces | [r]1,222 | [r]965 | 1,125 | 932 | 600 |
| Platinum | do. | [r]772 | [r]611 | 836 | 579 | 1,000 |
| **Total** | **do.** | **1,994** | **1,576** | **1,961** | **1,511** | **1,600** |
| Silver | thousand troy ounces | 893 | 799 | 841 | 815 | [3]706 |
| Tin: | | | | | | |
| Mine output, Sn content[e] | | 1,670 | 1,670 | 1,470 | 1,410 | 1,500 |
| Smelter output, metal | | 1,210 | 1,207 | 1,079 | 1,038 | 1,000 |

See footnotes at end of table.

TABLE 14—Continued

## ZIMBABWE: PRODUCTION OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

| Commodity | | 1984 | 1985 | 1986 | 1987[p] | 1988[e] |
|---|---|---|---|---|---|---|
| METALS—Continued | | | | | | |
| Tungsten, concentrate: | | | | | | |
| Gross weight | | 55 | 14 | 2 | 1 | 1 |
| W content[e] | | 29 | 10 | 1 | 1 | 1 |
| INDUSTRIAL MINERALS | | | | | | |
| Asbestos | | 165,385 | 173,580 | 163,989 | 193,925 | 190,000 |
| Barite | | 700 | 400 | 298 | 191 | 200 |
| Cement, hydraulic | | [e]650,000 | [e]700,000 | [e]750,000 | 810,712 | [3]775,736 |
| Clays: | | | | | | |
| Bentonite (montmorillonite) | | [e]64,000 | [e]68,000 | 71,987 | 116,802 | 113,157 |
| Fire clay | | 8,900 | 9,747 | 12,591 | 16,022 | 16,000 |
| Kaolin | | 1,350 | 1,104 | 901 | 780 | 95 |
| Feldspar | | 1,399 | 2,300 | 2,026 | 2,962 | 2,500 |
| Gem stones, precious and semiprecious: | | | | | | |
| Emerald | kilograms | 8 | 13 | 59 | 1,979 | 1,900 |
| Graphite | | 12,334 | 10,450 | 15,000 | 13,530 | 13,000 |
| Kyanite | | — | — | 1,851 | — | 1,850 |
| Lithium minerals, gross weight | | 22,548 | 27,910 | 32,760 | 14,959 | 25,000 |
| Magnesium compounds: Magnesite | | 21,642 | 19,385 | 22,649 | 28,991 | 30,000 |
| Mica | | 911 | 582 | 1,340 | 800 | 800 |
| Nitrogen: N content of ammonia | | 68,600 | 68,900 | 49,100 | 53,300 | 52,900 |
| Phosphate rock, marketable concentrate | thousand tons | 134 | 135 | 136 | 155 | 155 |
| Pigments, iron oxide[e] | | 1,000 | [r]1,000 | [3]207 | [r]200 | 200 |
| Quartz[6] | thousand tons | 32 | 103 | 145 | 41 | 50 |
| Stone: Limestone | do. | 1,152 | 1,323 | 1,407 | 1,537 | 1,600 |
| Sulfur: | | | | | | |
| Pyrite: Gross weight | | 56,986 | 57,392 | 62,506 | 46,606 | 50,000 |
| S content[e] | | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Byproduct acid, metallurgical and coal process gas[e] | | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| **Total** | | **30,000** | **30,000** | **30,000** | **30,000** | **30,000** |
| Talc | | 285 | 437 | 797 | 516 | 500 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Coal, bituminous | thousand tons | 3,110 | 3,120 | 4,047 | 4,848 | 4,900 |
| Coke, metallurgical[e 7] | do. | 200 | 200 | 200 | [3]592 | 600 |

[e] Estimated. [p] Preliminary. [r] Revised.

[1] Table includes data available through Oct. 20, 1989.

[2] "Mine output" figures are calculated from "metal" figures. "Metal" may include metal content of compounds/salts, and may include cobalt recovered from nickel-copper matte imported from Botswana for toll refining.

[3] Reported figure.

[4] Smelter copper includes impure cathodes produced by electrowinning in nickel processing.

[5] May include nickel content of nickel oxide.

[6] Includes rough and ground quartz as well as silica sand.

[7] Data represents output by the Wankie Colliery Co. Ltd. for years 1984–86 ending Aug. 31 of that stated; additional output by the Redcliff plant of Zisco Ltd. may total 250,000 metric tons per year of metallurgical coke and coke breeze.

TABLE 15

## ZIMBABWE: APPARENT EXPORTS OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

| Commodity | 1986 | 1987 | Destinations, 1987 | |
|---|---|---|---|---|
| | | | United States | Other (principal) |
| METALS | | | | |
| Aluminum: | | | | |
| Ore and concentrate | 256 | NA | | |
| Metal including alloys: | | | | |
| Unwrought | 63 | NA | | |
| Semimanufactures | — | 3 | — | All to United Kingdom. |
| Antimony: Ore and concentrate | NA | 168 | — | All to Belgium-Luxembourg. |
| Beryllium: Ore and concentrate | NA | 73 | 73 | |
| Chromium: | | | | |
| Ore and concentrate | 2,156 | 69 | — | All to Japan. |
| Oxides and hydroxides | NA | 2,471 | 2,471 | |
| Columbium and tantalum: Ash and residue containing columbium and tantalum | 421 | NA | | |
| Copper: | | | | |
| Matte and speiss including cement copper | 602 | NA | | |
| Ash and residue containing copper | 556 | NA | | |
| Metal including alloys: | | | | |
| Scrap | NA | 94 | — | All to Belgium-Luxembourg. |
| Unwrought | [2]21,660 | 12,884 | — | Italy 12,407. |
| Gold: Metal including alloys, unwrought and partly wrought value, thousands | $317 | $168 | — | All to Belgium-Luxembourg. |
| Iron and steel: Metal: | | | | |
| Scrap | NA | 2,173 | — | Republic of Korea 1,979; Taiwan 176. |
| Pig iron, cast iron, related materials | [2]605 | NA | | |
| Ferroalloys: | | | | |
| Ferrochromium | 113,220 | 74,214 | 41,579 | Italy 21,782; Belgium-Luxembourg 6,402. |
| Ferromanganese | 93 | 120 | — | All to Philippines. |
| Ferronickel | — | 22 | — | All to Spain. |
| Ferrosilicochromium | 20,795 | 3,509 | 1,869 | Spain 1,640. |
| Unspecified | 113,125 | 41,867 | — | Japan 29,520; United Kingdom 6,446. |
| Steel, primary forms | [2]58,255 | 106,929 | — | Italy 42,820; Taiwan 41,101; Republic of Korea 13,222. |
| Semimanufactures: | | | | |
| Bars, rods, angles, shapes, sections | [2]139,542 | 6,473 | 16 | United Kingdom 6,457. |
| Universals, plates, sheets | 3,473 | 1,858 | 1,848 | Taiwan 10. |
| Hoop and strip | 29 | NA | | |
| Rails and accessories | NA | 78 | — | All to United Kingdom. |
| Wire | [2]9,239 | 421 | — | Belgium-Luxembourg 237; United Kingdom 164. |
| Tubes, pipes, fittings | 404 | 1,872 | — | Portugal 1,856. |
| Lead: Metal including alloys, unwrought | NA | 25 | — | All to Pakistan. |

See footnotes at end of table

TABLE 15—Continued

## ZIMBABWE: APPARENT EXPORTS OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

| Commodity | | 1986 | 1987 | Destinations, 1987 | |
|---|---|---|---|---|---|
| | | | | United States | Other (principal) |
| METALS—Continued | | | | | |
| Lithium: Ore and concentrate | | [2]22,837 | 7,672 | 7,672 | |
| Nickel: | | | | | |
| Matte and speiss | | 275 | NA | | |
| Metal including alloys: | | | | | |
| Scrap | value, thousands | NA | $159 | — | All to Japan. |
| Unwrought | | NA | 9,909 | 2,500 | Japan 6,016; Spain 580. |
| Semimanufactures | | NA | 18 | — | Japan 10; Republic of Korea 8. |
| Unspecified | | [2]14,326 | NA | | |
| Platinum-group metals: | | | | | |
| Waste and sweepings | value, thousands | NA | $18 | — | All to United Kingdom. |
| Metals including alloys, unwrought and partly wrought | do. | $51 | $69 | — | All to Switzerland. |
| Silver: | | | | | |
| Ore and concentrate | do. | $1 | $96 | — | All to United Kingdom. |
| Waste and sweepings | do. | $2,337 | NA | | |
| Tin: Metal including alloys: | | | | | |
| Unwrought | | NA | 237 | 35 | Belgium-Luxembourg 169; Denmark 28. |
| Semimanufactures | | — | 9 | — | All to Spain. |
| Unspecified | | [2]1,322 | NA | | |
| Titanium: Metal including alloys, semimanufactures | | — | 1 | — | All to United Kingdom. |
| Other: | | | | | |
| Ores and concentrates of precious metals | kilograms | NA | 25 | 25 | |
| Ashes and residues | | 28 | 16 | — | Do. |
| Base metals including alloys, all forms | | 108 | NA | | |
| Precious metals including alloys, waste and scrap | value, thousands | [2]$816 | NA | | |
| INDUSTRIAL MINERALS | | | | | |
| Abrasives, n.e.s.: Natural: Corundum, emery, pumice, etc. | do. | $82 | NA | | |
| Asbestos, crude | | [2]167,970 | 97,342 | 57 | Japan 45,802; Spain 15,217; Republic of Korea 9,766. |
| Cement | | [2]77,929 | NA | | |
| Clays, crude | | NA | 697 | — | Denmark 662; Japan 35. |
| Diamond: | | | | | |
| Gem, not set or strung | value, thousands | [2]$4,201 | NA | | |
| Industrial stones | do. | $26 | NA | | |
| Feldspar, fluorspar, related materials | | 180 | NA | | |
| Fertilizer materials: Manufactured, phosphatic | | 3,168 | NA | | |

See footnotes at end of table.

TABLE 15—Continued

## ZIMBABWE: APPARENT EXPORTS OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

| Commodity | | 1986 | 1987 | Destinations, 1987 | |
|---|---|---|---|---|---|
| | | | | United States | Other (principal) |
| INDUSTRIAL MINERALS—Continued | | | | | |
| Graphite, natural | | ([2 3]) | 1,263 | 156 | United Kingdom 679; Portugal 388. |
| Kyanite and related materials | | 18 | 662 | — | All to Denmark. |
| Magnesium compounds: Magnesite, crude | value, thousands | [2]$691 | NA | | |
| Mica: Crude including splittings and waste | | 657 | NA | | |
| Precious and semiprecious stones other than diamond: | | | | | |
| Natural | value, thousands | $1,396 | $1,643 | $243 | Switzerland $1,256; Italy $85. |
| Synthetic | do. | $30 | NA | | |
| Stone, sand and gravel: | | | | | |
| Dimension stone: | | | | | |
| Crude and partly worked | | NA | 40,038 | 379 | Japan 34,268; Italy 2,808; Canada 2,201. |
| Worked | | — | 12 | 11 | Italy 1. |
| Quartz and quartzite | | NA | 258 | — | Belgium-Luxembourg 151; United Kingdom 74. |
| Unspecified | | [2]29,579 | NA | | |
| Talc, steatite, soapstone, pyrophyllite | value, thousands | NA | $7 | $7 | |
| Other: Crude | | 4,516 | 3,611 | — | All to Japan. |
| MINERAL FUELS AND RELATED MATERIALS | | | | | |
| Coal: All grades including briquets | | [2]64,645 | NA | | |
| Coke and semicoke | | [2]113,133 | NA | | |

NA Not available.

[1] Table prepared by Virginia A. Woodson. Owing to a lack of official trade data published by Zimbabwe, this table should not be taken as a complete representation of this country's mineral exports. These data have been compiled from various sources, which include United Nations information, data published by trading partner countries, and partial official trade data of Zimbabwe. Unless otherwise specified, data are compiled from trade statistics of individual trading partners.

[2] Central Statistical Office, Harare, Zimbabwe. Quarterly Digest of Statistics, Dec. 1987.

[3] Unreported quantity valued at $7,024,000.

a subsidiary of Lonrho PLC, closed its Inyati Mine, which had a 3,000-ton-per-year metal capacity. They disposed of all the assets.

**Gold.**—Rio Tinto Zimbabwe (Riozim) planned to spend $15 million on a new treatment facility at Eiffel Flats. The plant would have fine-grind and thickener sections and would employ carbon-in-leach and column flotation for recovery. Throughput would be 700,000 tons per year and would consist primarily of tailings of the Cam and Motor Mines. Such tailings amounted to 5 million tons and averaged 0.04 troy ounce per ton. Commissioning was planned for late 1989. Gold output would be about 20,000 troy ounces annually, and recovery would improve from 30% to 70%. Riozim conducted geochemical exploration on six Exclusive Prospecting Orders and three other claim areas. Preliminary analysis was to be followed by drilling and metallurgical tests.

Gwalla International Ltd.'s 75%-owned Chase Minerals had an option to purchase an 80% interest in old mine workings that had a 10-kilometer strike length near Kwekwe. Resources were several hundred thousand tons, with about 0.039 troy ounce of gold per ton. Chase held title to 2.1 million tons of tailings from the Connemara Mine. These tailings had reported grade of about 0.032 troy ounce per ton. Additional resources were reported at the Hope Fountain project near Bulawayo, in which Chase had the option to obtain 60%.

Cluff Mineral Exploration (Zimba-

TABLE 16

## ZIMBABWE: APPARENT IMPORTS OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

| Commodity | 1986 | 1987 | Sources, 1987 | |
|---|---|---|---|---|
| | | | United States | Other (principal) |
| METALS | | | | |
| Aluminum: | | | | |
| Oxides and hydroxides | 1 | 1 | 1 | |
| Metal including alloys: | | | | |
| Scrap | — | 22 | — | All from Denmark. |
| Unwrought | 303 | 1 | — | All from United Kingdom. |
| Semimanufactures | ([2 3]) | 364 | 46 | Switzerland 88; Egypt 81. |
| Arsenic: Oxides and acids | — | 1 | — | All from United Kingdom. |
| Chromium: Oxides and hydroxides | 4 | — | | |
| Cobalt: Oxides and hydroxides | 1 | — | | |
| Copper: | | | | |
| Ash and residue containing copper | 54 | NA | | |
| Metal including alloys: | | | | |
| Unwrought | 16 | NA | | |
| Semimanufactures | 99 | 61 | 27 | Italy 19; United Kingdom 6. |
| Iron and steel: Metal: | | | | |
| Scrap | 31 | NA | | |
| Pig iron, cast iron, related materials | 46 | 1 | — | All from United Kingdom. |
| Ferroalloys: Silicon metal | 22 | NA | | |
| Steel, primary forms | — | 1 | — | Do. |
| Semimanufactures: | | | | |
| Bars, rods, angles, shapes, sections | ([3 4]) | 199 | — | United Kingdom 146; Italy 33. |
| Universals, plates, sheets | ([3 5]) | 617 | 132 | Canada 259; United Kingdom 90. |
| Hoop and strip | 360 | 247 | — | Japan 205; Belgium-Luxembourg 39. |
| Wire | 187 | 167 | — | United Kingdom 92; Belgium-Luxembourg 50. |
| Tubes, pipes, fittings | ([6]) | 135 | 1 | United Kingdom 52; Italy 36; Japan 30. |
| Castings and forgings, rough | 225 | NA | | |
| Lead: | | | | |
| Oxides | — | 10 | — | All from United Kingdom. |
| Metal including alloys, semimanufactures | 1 | 1 | — | Do. |
| Lithium: Oxides and hydroxides | — | 12 | 12 | |
| Magnesium: Metal including alloys, semimanufactures | — | 16 | 16 | |
| Manganese: | | | | |
| Ore and concentrate: Metallurgical-grade | 209 | 52 | — | All from Netherlands. |
| Oxides | 18 | 36 | — | All from Greece. |
| Molybdenum: Metal including alloys, all forms | 2 | — | | |
| Nickel: Metal including alloys, semimanufactures | 4 | 1 | — | All from Italy. |
| Platinum-group metals: Metals including alloys, unwrought and partly wrought value, thousands | $7 | NA | | |

See footnotes at end of table.

TABLE 16—Continued

## ZIMBABWE: APPARENT IMPORTS OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

| Commodity | | 1986 | 1987 | Sources, 1987 | |
|---|---|---|---|---|---|
| | | | | United States | Other (principal) |
| METALS—Continued | | | | | |
| Silver: Metal including alloys, unwrought and partly wrought | value, thousands | $97 | $1 | — | All from United Kingdom. |
| Tin: Metal including alloys: | | | | | |
| Unwrought | | — | 1 | — | Do. |
| Semimanufactures | | 13 | NA | | |
| Titanium: Oxides | | 3 | 2 | — | All from Denmark. |
| Vanadium: | | | | | |
| Oxides and hydroxides | | — | 1 | 1 | |
| Pentoxides | | 8 | — | | |
| Zinc: | | | | | |
| Oxides | | 28 | 4 | — | All from United Kingdom. |
| Metal including alloys, all forms | value, thousands | [3]$3,793 | NA | | |
| Other: Base metals including alloys, all forms | | 3 | — | | |
| INDUSTRIAL MINERALS | | | | | |
| Abrasives, n.e.s.: | | | | | |
| Natural: Corundum, emery, pumice, etc. | | 151 | 322 | — | Turkey 260; Greece 39. |
| Grinding and polishing wheels and stones | | [7]12 | 2 | — | Japan 1; United Kingdom 1. |
| Asbestos, crude | | NA | 734 | — | All from Ireland. |
| Boron materials: Oxides and acids | | 4 | 9 | 9 | |
| Cement | | NA | 110 | — | United Kingdom 74; Italy 36. |
| Chalk | | 38 | 11 | — | All from United Kingdom. |
| Diamond: | | | | | |
| Gem, not set or strung | value, thousands | $2 | NA | | |
| Industrial stones | do. | $2 | $1 | — | All from Switzerland. |
| Fertilizer materials: Manufactured: | | | | | |
| Ammonia | do. | [3]$9,996 | NA | | |
| Nitrogenous | | 9,683 | 31 | — | Netherlands 20; Belgium-Luxembourg 11. |
| Potassic | | 18,414 | NA | | |
| Graphite, natural | | 5 | — | | |
| Gypsum and plaster | | 163 | NA | | |
| Lime | value, thousands | [3]$3,013 | NA | | |
| Magnesium compounds: Other | | 1 | 1 | 1 | |
| Mica: | | | | | |
| Crude including splittings and waste | | 1 | — | | |
| Worked including agglomerated splittings | | — | 4 | — | All from United Kingdom. |

See footnotes at end of table.

TABLE 16—Continued

## ZIMBABWE: APPARENT IMPORTS OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

| Commodity | | 1986 | 1987 | Sources, 1987 | |
|---|---|---|---|---|---|
| | | | | United States | Other (principal) |
| INDUSTRIAL MINERALS—Continued | | | | | |
| Precious and semiprecious stones other than diamond: | | | | | |
| Natural | value, thousands | $125 | $36 | — | United Kingdom $23; Switzerland $13. |
| Synthetic | do. | NA | $5 | — | All from Switzerland. |
| Salt and brine | | 7,542 | 323 | — | All from United Kingdom. |
| Sodium compounds, n.e.s.: Carbonate, manufactured | | 72 | NA | | |
| Stone, sand and gravel: Dimension stone, crude and partly worked | | NA | 472 | — | All from Ireland. |
| Sulfur: Elemental, colloidal, precipitated, sublimed | | 4 | — | | |
| Talc, steatite, soapstone, pyrophyllite | | 36 | 25 | — | Republic of Korea 18; Denmark 7. |
| Other: Crude | | 11 | — | | |
| MINERAL FUELS AND RELATED MATERIALS | | | | | |
| Asphalt and bitumen, natural | | 1 | 159 | — | All from Trinidad and Tobago. |
| Carbon black | | 55 | 13 | — | All from United Kingdom. |
| Coal: All grades including briquets | value, thousands | [3]$15,743 | NA | | |
| Petroleum refinery products: | | | | | |
| Gasoline | 42-gallon barrels | 480 | 1,593 | — | Australia 1,236; Netherlands 357. |
| Mineral jelly and wax | do. | 9 | 181 | — | Belgium-Luxembourg 87; United Kingdom 55. |
| Distillate fuel oil | do. | 97 | 52 | — | All from United Kingdom. |
| Lubricants | do. | 10,476 | 14,749 | 224 | United Kingdom 10,612; Netherlands 3,913. |
| Residual fuel oil | do. | NA | 1,232 | — | All from Belgium-Luxembourg. |
| Bitumen and other residues | do. | 315 | 109 | — | All from Italy. |
| Bituminous mixtures | do. | 503 | 170 | — | All from United Kingdom. |

NA Not available.

[1] Table prepared by Virginia A. Woodson. Owing to a lack of official trade data published by Zimbabwe, this table should not be taken as a complete representation of this country's mineral imports. These data have been compiled from various sources, which include United Nations information, data published by trading partner countries, and partial trade data of Zimbabwe. Unless otherwise specified, data are compiled from trade statistics of individual trading partners.

[2] Unreported quantity valued at $8,622,000.

[3] Central Statistical Office, Harare, Zimbabwe. Quarterly Digest of Statistics, Dec. 1987.

[4] Unreported quantity valued at $6,561,000.

[5] Unreported quantity valued at $39,692,000.

[6] Unreported quantity valued at $3,895,000.

[7] Excludes unreported quantity exported by Canada valued at $20,000.

bwe) Ltd., a subsidiary of Cluff Resources PLC of the United Kingdom, reported production of 23,200 troy ounces from the Royal Family, Freda, and Rebecca Mines. Heap leaching has been employed at the Royal Family Mine since 1984. Annual output was 7,000 troy ounces. At full production, the Freda and Rebecca opencast mines, newly commissioned in 1988, would bring Cluff's total capacity to 80,000 troy ounces per year. The Freda Mine consisted of a 50,000-ton-per-month heap-leaching operation of an oxide ore capping, and the Rebecca Mine had a 60,000-ton-per-month flotation and cyanidation process using adjacent sulfide ore. Development cost of the Freda Mine was $4.3 million, including purchase of mineral rights, plus property and development cost. Operating costs were less than $200 per ounce. Estimated life of the Freda Mine was 2 to 3 years, and of the Rebecca Mine 7 to 8 years. At closure, about 46 million tons of rock would have been mined from both open pits. The waste dumps were to be recontoured and vegetated, and the pits were to be used as water reservoirs. The labor force of 128 was entirely Zimbabwean. Cluff was spending $1.6 million annually on exploration.

Lonrho PLC commenced a number of projects to expand gold production at its mines. Mill expansion at Shamva would increase the capacity to treat ore from 12,000 tons per month to 20,000 tons per month and would yield an additional 10,450 troy ounces of gold per year. Full commissioning was expected about June 1990. Expansion of the Athens Mine was completed, and gold production was increased from 965 to 1,610 troy ounces per month. Ore control problems prevented the full planned output of about 2,250 troy ounces per month. The Athens Mine had two carbon-in-pulp plants for treating surface ore and re-treating tailings, and a plant for treating underground ore. Plans for expanding output at the Redwing and Howe Mines were underway. Lonrho was exploring for large, low-grade gold deposits that would be amenable to heap leaching.

Delta Gold NL of Australia, through its subsidiary Masasa Mines, commenced assessment of the abandoned Pickstone Mine near Chegutu. Developed reserves were 240,000 tons grading 0.228 troy ounce per ton. Additional drilling was planned, and if successful, could lead to similar evaluation of the nearby Peerless Mine.

Union Carbide Corp. had three gold mines, Gaika, Camperdown, and Lennox, producing a total of 1,000 troy ounces per month, and had plans to triple output over a 5-year period. Heap leaching was conducted at Gaika Mine. Union Carbide reported that 25% of aftertax profits was repatriated, and 25% was placed in Government bonds.

**Iron and Steel.**—As a continuation of Zisco's modernization plan, bids were requested on an iron ore sinter plant with a 1.5-to-2-million-ton-per-year capacity to be built at or near the Redcliff facility. Ore feed would be mainly from the Ripple Creek Mine, where the mineralization was limonitic. Product from the sinter plant would provide a 70% to 100% sinter feed to the blast furnaces for production of 80,000 tons per month of metal.

Ferroalloys.—ZIMASCO placed its No. 2 electric furnace back into operation in February. The furnace had a 12.4-megavolt-ampere capacity, and the annual high-carbon ferrochromium output was 15,000 tons. A new 3-megavolt-ampere induction furnace to remelt chromite fines was constructed at yearend for the production of an additional 15,000 tons per year of high-carbon ferrochromium. Full operation of ZIMASCO's six electric furnaces and the new furnace would provide an annual output of 190,000 tons. Current operations include five 17-megawatt furnaces and one 12.4-megawatt furnace. Zimalloys accounted for the remainder of ferrochromium output. Zimbabwe was the fourth largest ferrochromium producer in the world.

**Lead.**—Lonrho proceeded with construction of a plant to recover lead concentrates at the Redwing gold mine. Concentrates would be sold locally for processing.

**Nickel.**—Riozim commenced test modification of its Empress nickel refinery to support the high copper matte feed, which was being toll refined for BCL Ltd. in Botswana. Capital expenditures for the test work were $2.5 million. Feed material from other sources in Botswana could also be accommodated at the refinery.

AAC's subsidiary, Bindura Nickel Corp., reported a profit of $54 million on sales of 11,014 tons of nickel for the year ending December 31, 1988. The company had a loss of $4.4 million in 1987.

**Platinum-Group Metals.**—Delta Gold NL completed a prefeasibility study of its Hartley platinum-group metals project, listing capital costs of about $180 million for a plant to process 2 million tons per year of ore over a 20-year period. Annual output from converter matte, which was to be toll refined in Europe or North America, was estimated at 100,000 troy ounces of platinum, 84,000 troy ounces of palladium, 8,000 troy ounces of rhodium, 10,000 troy ounces of gold, 2,700 tons of nickel, and 1,700 tons of copper. Based on drill-core data obtained from Union Carbide Corp.'s earlier drilling program of 177 drill holes, proven ore reserves were 28 million tons grading 0.09 troy ounce per ton of platinum, 0.064 troy ounce per ton of palladium, 0.016 troy ounce per ton of gold, 0.21% nickel, and 0.14% copper. Probable reserves were 34 million tons at 0.087 troy ounce of platinum per ton, and possible reserves were 58 million tons at 0.087 troy ounce per ton.

Riozim, in a joint venture with AAC and Robertson Group PLC of the

United Kingdom, was reevaluating and extending exploration on platinum claims held by it and AAC in the Hartley Complex of the Great Dyke. Mhondoro Mining Co., a subsidiary of Robertson, was to invest $2.8 million over 5 years, at which time it would earn a 24% interest in the project, and Riozim and AAC would earn 38% each. Its task was to correlate existing data, conceptualize the project for a drilling program, and if warranted, conduct a feasibility study on developing selected sites. Riozim had previously postponed attempts to develop the Hartley Complex for platinum-group metals and their byproducts. This decision was based both on its experience at the Zinca Mine and on Union Carbide Corp.'s experience at the Mimosa Mine. Both projects had developed technically successful mining and metallurgical processes, but neither was economically feasible.

*Industrial Minerals.*—**Cement.**—Portland Holdings reported high demand for cement as the construction industry flourished. Profits were up $1.1 million in the 6-month period ending February 29, 1988. Prices were fixed by the Government, and the company reported that increasing costs were squeezing profits.

**Lithium.**—Corning Glass Works of the United States, which imports petalite from Bikita Minerals, reported some of the costs and logistics required to ship lithium minerals via an extensive and varied transport system in southern Africa. Costs per ton were reported as follows: ocean freight, $30; stevedoring, $18; and storage, handling, and trucking, $32. For transport, 1-ton units of ground petalite were loaded into polypropylene bags. These bags were then trucked 60 miles from the mine site at Bikita to the railhead at Masvingo, and were transferred to the NRZ and moved 1,230 miles to Durban, Republic of South Africa. Warehousing and transshipment was by Rennies Corp. Sea transport was by ocean charter 8,600 miles to Baltimore and Martinsburg, West Virginia, was the final destination. Because of the nature of petalite and its end uses, special precautions were required in order to prevent contamination, which was primarily from iron-bearing dust. The precautions included vacuuming of the bags prior to ocean transit.

**Gem Stones.**—The Sandawana emerald mine reportedly had an annual output of 20 to 30 kilograms of high-quality stones. The country's aquamarine output was estimated at about 100 kilograms of facet-grade material out of a total production of 1,000 kilograms annually. Cordierite output was about 5 kilograms per year.

*Mineral Fuels.*—Zimbabwe remained totally dependent upon imported petroleum. Refined products were imported primarily via pipeline from the petroleum terminal at Beira in Mozambique. Gasoline imported by Zimbabwe was blended with sugar-cane-derived ethanol in the ratio of 87% gasoline to 13% ethanol.

The Government announced the construction of a 300-megawatt extension to the Kariba South power station. Also under consideration was expansion of the coal-fired powerplant at Hwange, and a new $500 million hydroelectric station at Batoka Gorge on the Zambesi River. Discussion was underway with Mobil Oil Corp. for an exploration agreement for petroleum in the Zambesi valley.

Wankie Colliery Co. Ltd. had a project under negotiation to supply clean coke-oven gas to the Hwange Power Station as a substitute for imported oil. Additionally, participation with Zisco at Redcliff for construction of a plant for downstream processing of coal tar and benzol was planned.

**Coal.**—Wankie Colliery Co. Ltd.'s turnover was up 17% to $70.5 million for the year ending February 28, 1989. The increase was mainly due to a 13.5% price increase granted by the Government in October and to improved product mix with the greater availability of higher priced coke. Despite improved turnover, cash availability was inadequate to finance loan and interest payments of $17 million, as well as capital expenditures of $11 million. Negotiations were underway for a $6.7 million loan with a commercial bank. Coal sales were 4.32 million tons compared with sales of 4.58 million tons the previous fiscal year. The decline was attributed to lack of transportation to serve market demand, which was estimated at 4.8 million tons annually. Sales to the Hwange Power Station were 2.07 million tons, or about 176,000 tons below the previous fiscal year.

Output from the No. 3 underground colliery improved. However, travel distances to working faces were approaching the economic limit in the northern reserve area. A contract for delivery of load-haul-dump vehicles was canceled owing to faulty vehicle construction, thus delaying a mechanization trial planned for the area.

About 85% of output continued to be from the open pit mine, where production was 4.22 million tons. Spoil dumps were being rehabilitated and revegetated.

Riozim was granted mining title to 538 hectares in order to develop the coal reserves at Sengwa. It also had the right to continue prospecting in the area covered by an Exclusive Prospecting Order. Under the terms of the grant, Riozim was required to commence work in the area and produce 3,600 tons of coal per month. Production capacity of 100,000 tons per year was possible by 1990. Sengwa Colliery (Pvt.) Ltd. was formed on a joint-venture basis between Riozim and the Government. The grant was to last for 15 years, and the Government had the right to 51% share in Sengwa coal. The Government had under construction a road valued at $11.1 million between Gokwe and Siabuwa to gain access to

the isolated coal reserve area. Riozim was required to supply coal, which would substitute for imported coal. Reserves were estimated at 200 million tons of low-sulfur and low-phosphorus coal with less than 20% ash.

**Coke.**—The newly refurbished coke ovens and byproducts plants were fully operational. Sales were 174,233 tons compared with 51,914 tons previously. Export markets temporarily lost during the refurbishing phase were reportedly regained.

**Uranium.**—Saarberg Interplan of the Federal Republic of Germany reported the existence of a small uranium deposit in the vicinity of Dande in northeastern Zimbabwe. Saarberg had been exploring in Zimbabwe for a number of years, and the discovery was part of a joint venture with a Japanese company. Grade was about 0.9% $U_3O_8$. A decision to build a pilot plant to determine process parameters and cost had yet to be made.

[1] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[2] Prepared by Lloyd E. Antonides, physical scientist, Division of International Minerals.

[3] Values converted from Botswana pula (P) to U.S. dollars at the rate of P1.8159 = US$1 for 1988; P1.6779 in 1987.

[4] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[5] Where necessary, values have been converted from Lesotho maloti (M) to U.S. dollars at the rate M2.26 = US$1.00.

[6] Prepared by Harold R. Newman and Lloyd E. Antonides, physical scientists, Division of International Minerals.

[7] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[8] Where necessary, values have been converted from Mozambique meticais (M) to U.S. dollars at the rate of M525.00 = US$1.00.

[9] An average of 44,084 Mozambique workers were employed in South African gold mines and 1,012 in coal mines. 1988 Annual Report, Chamber of Mines of South Africa.

[10] Prepared by George A. Morgan, physical scientist, Division of International Minerals.

[11] Where necessary, values have been converted from South African rands (R) to U.S. dollars at the rate of R2.04 = US$1.00 for 1987 and R2.26 = US$1.00 for 1988.

[12] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[13] Where necessary, values have been converted from Swazi emalangeni (E) to U.S. dollars at the rate of E2.28 = US$1.00.

[14] This deposit has also been spelled Dokolwayoy and Dvokolwayo.

[15] Prepared by Lloyd E. Antonides, physical scientist, Division of International Minerals.

[16] Where necessary, Zambian kwachas (K), have been converted from K to U.S. dollars at the rate of K8.2237 = US$1.00 for 1988 and K8.8889 = US$1.00 for 1987.

[17] Prepared by George A. Morgan, physical scientist, Division of International Minerals.

[18] Where necessary, values have been converted from Zimbabwean dollars (ZD) to U.S. dollars at the rate of ZD1.66 = US$1.00 for 1987 and ZD1.80 = US$1.00 for 1988.